FEBRUARY, 1949
VOL. 4, NO. 2

PETROLEUM PROCESSING

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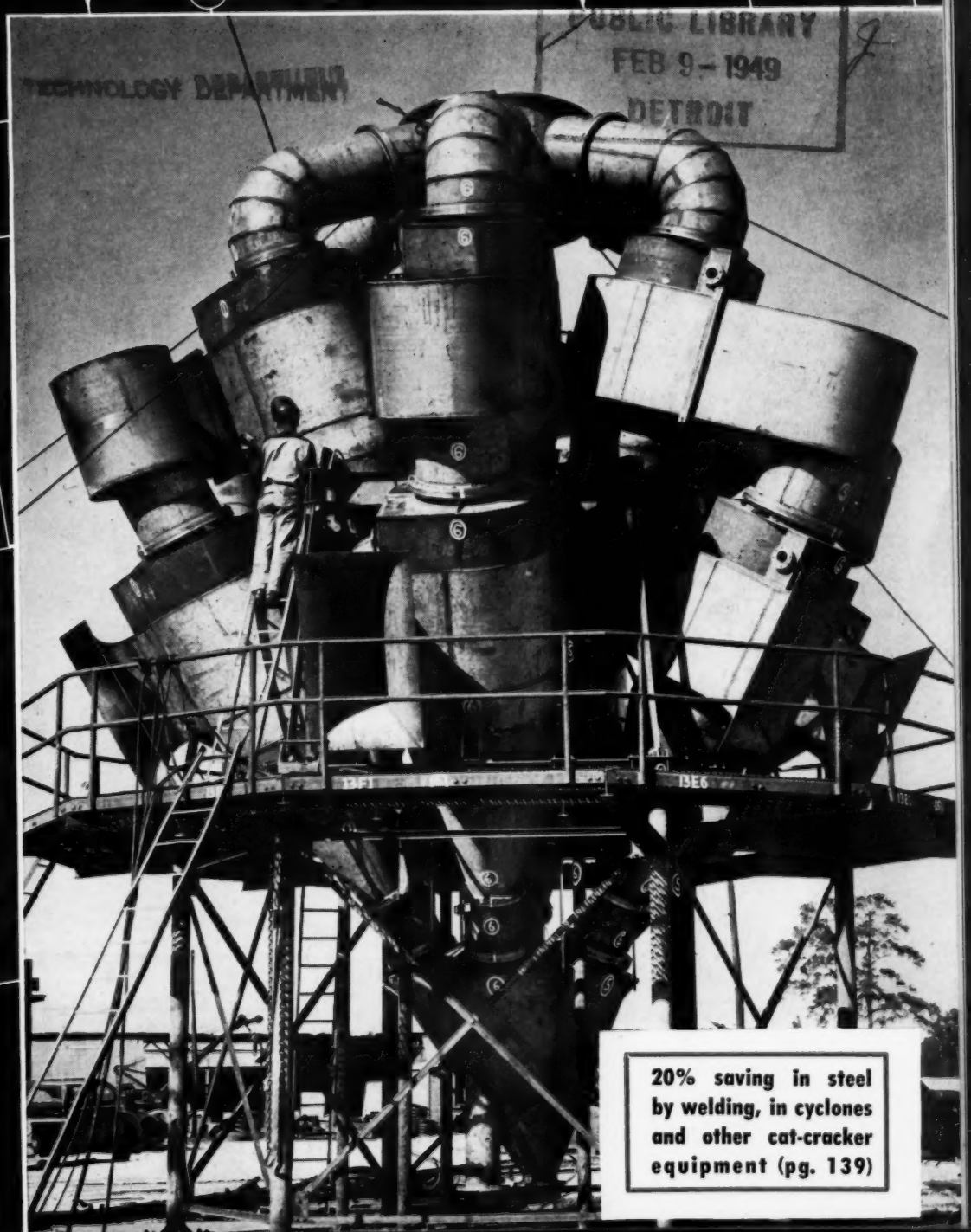

20% saving in steel by welding, in cyclones and other cat-cracker equipment (pg. 139)

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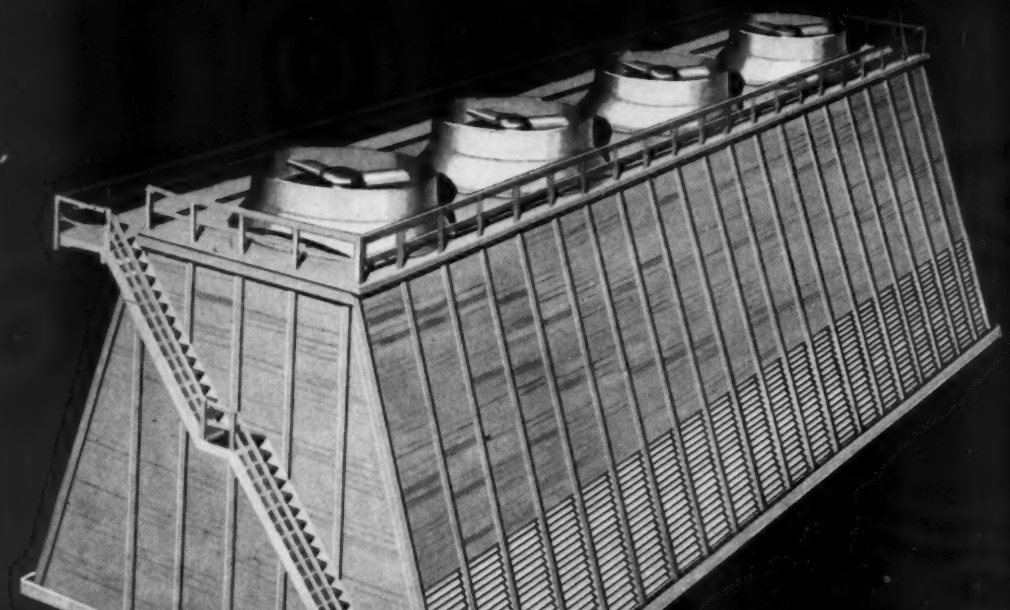

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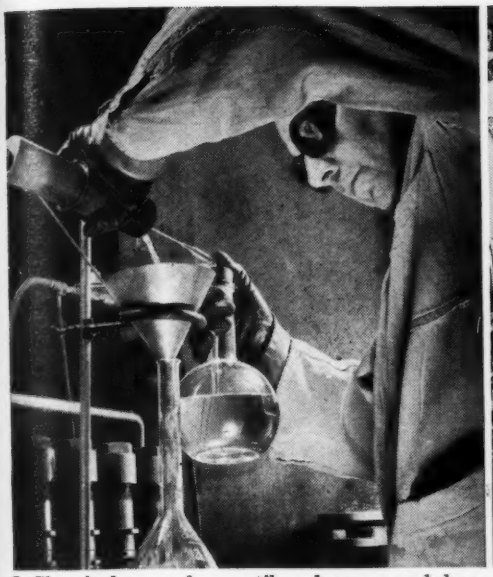
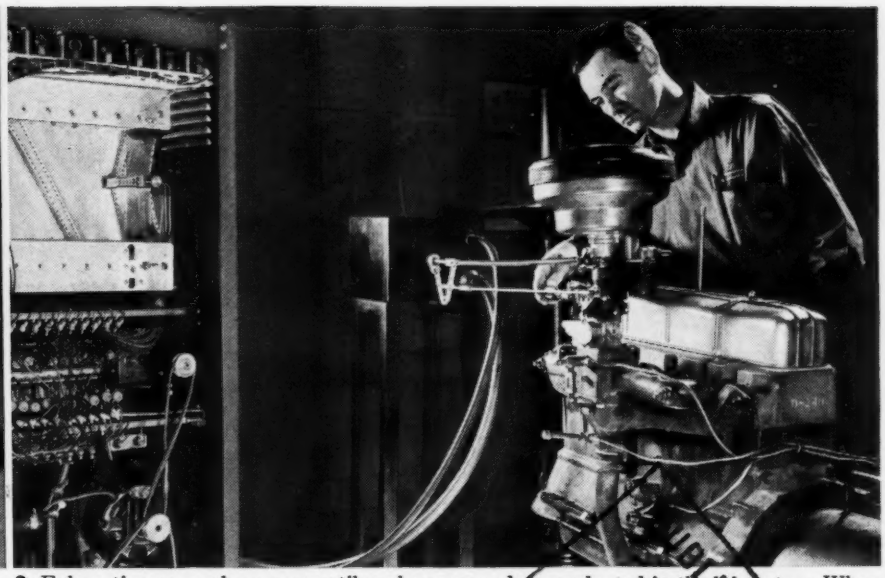


1. Chemical research on antiknock compounds has been a continuous program at Ethyl for 26 years.



2. Exhaustive research on new antiknock compounds is conducted in the laboratory. When results are favorable, these new fluids are proved in road test vehicles and in commercial fleets.

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DETROIT

DEVELOPING AND PROVING "ETHYL" ANTIKNOCK COMPOUNDS OF THE FUTURE

THE manufacturer of antiknock fluid has an obligation to refiners to do far more than manufacture a given compound. He must constantly improve his product and keep it up-to-date in terms of the gasoline with which it will be blended to insure maximum quality when added to the gasolines produced by the petroleum industry and used in the engines produced by the automotive industry. Thus technical advances in these two industries must be matched by equivalent advances in the formulation of "Ethyl" antiknock compound.

How well the Ethyl Research Laboratories have lived up to this obligation is indicated by the numerous changes—five of them major improvements—which have been made in "Ethyl" antiknock compound during the twenty-six years it has been marketed.

More than tetraethyllead

While tetraethyllead is the principal ingredient of "Ethyl" antiknock fluid, it is only one of a number of ingredients. Determining the most suitable other ingredients and their most effective proportions has always been a major part of the research program of the Ethyl Laboratories.

To this research Ethyl has devoted thousands of hours of engine studies in the laboratory, over ten million miles of test vehicle operation at the Detroit and San Bernardino Laboratories, and over 40 million miles of commercial vehicle operation in large truck and bus fleets operating under a wide range of conditions in different parts of the country and under the close supervision of Ethyl engineers. The last major change in "Ethyl" brand antiknock compound was made only after more than 17,000 hours of laboratory engine tests and over nine million miles of road tests had confirmed the desirability of the change.

The aim of all this research is to give refiners the fluid which will enable them to raise the antiknock quality of their gasoline at the lowest possible cost . . . and to make sure that gasoline containing "Ethyl" fluid gives the best possible performance under the wide range of conditions to be met.

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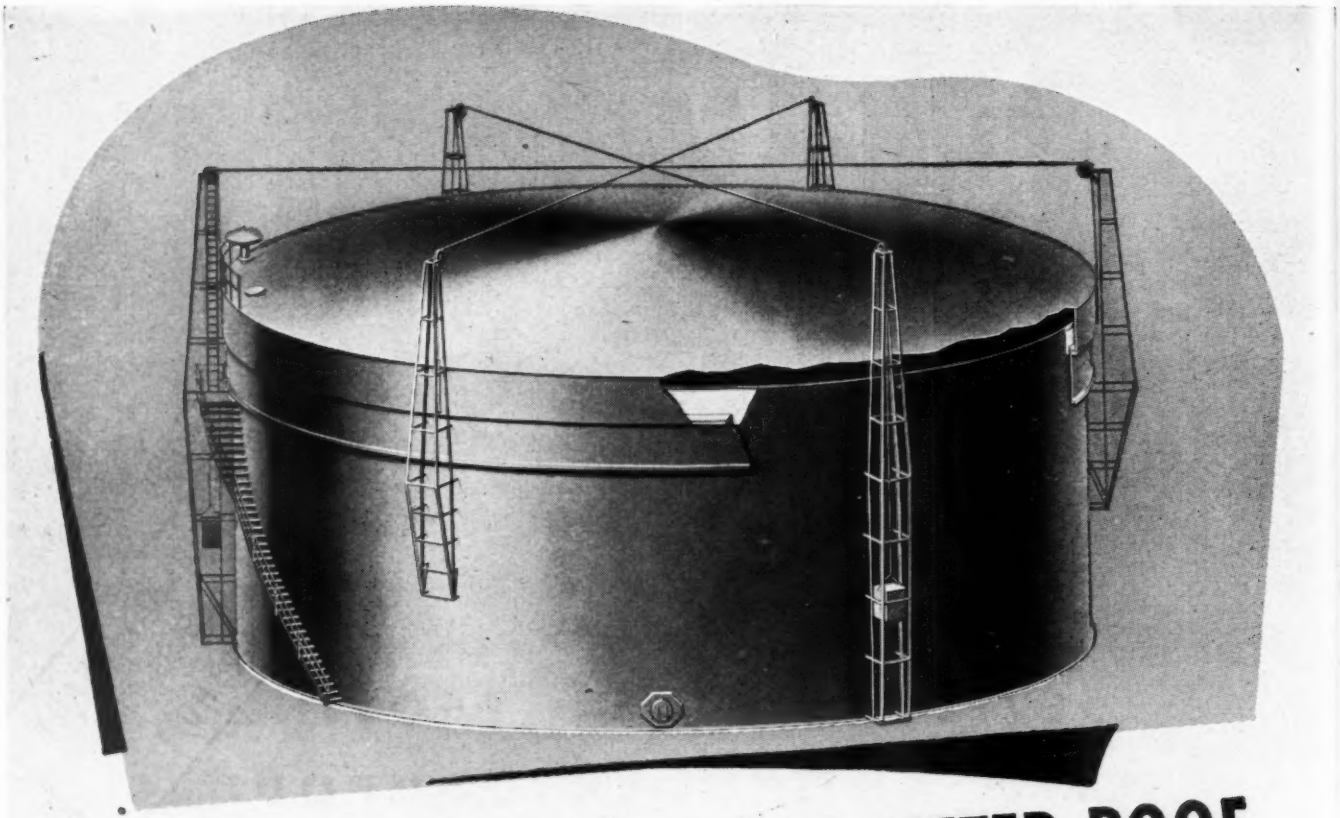

THE WIGGINS DRY SEAL LIFTER ROOF

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Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

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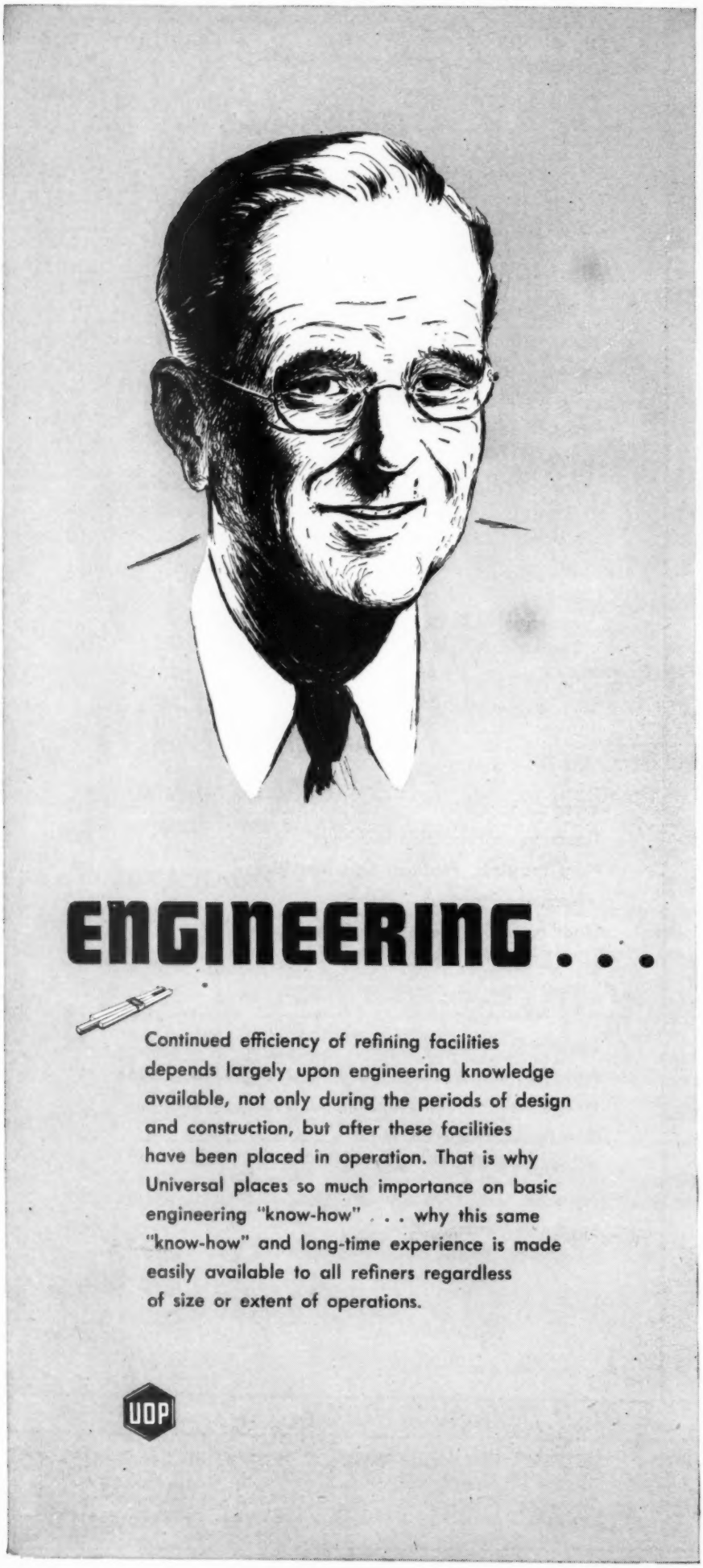
ENGINEERING . . .
Continued efficiency of refining facilities depends largely upon engineering knowledge available, not only during the periods of design and construction, but after these facilities have been placed in operation. That is why Universal places so much importance on basic engineering "know-how" . . . why this same "know-how" and long-time experience is made easily available to all refiners regardless of size or extent of operations.
UOP

Aurora Reports on Second Turnaround of Fluid Unit

By Max M. Fisher
Vice-President, Aurora Gasoline Company

FOLLOWING the second shutdown of our 4,000 bbl./day fluid catalytic cracking unit at Detroit, we began the third run at 11 PM, Nov. 3, 1948. This second shutdown required only 79 hours after a total of 324 days on stream. Efficiency of our second run has been calculated at 98.5 percent, and combined with the results of our first run of 176 days, shows an overall efficiency for the unit of 96.1 percent. Tables below give this information in detail.

Max M. Fisher

The fluid unit, designed and engineered by Universal Oil Products Company, was placed on stream for the first time in June of 1947. It combines reactor and regenerator in a single column, a factor that resulted in materially reduced construction costs when compared with those required by the fluid cat cracker of earlier design. We consider this a real saving as the unit has afforded excellent flexibility with improved product return. We are now equipped to handle a wide range of charging stocks without difficulty and are able to keep pace with market demands as they change.

The design of the cat cracker itself, together with the engineering and field service offered by its designers, has proved in a large measure responsible for the efficient operating schedules shown in these tables.

Report of Second Run

Date & Time of Actual Startup ... 6 PM, Dec. 12, 1947
Date & Time on Stream ..... 4:30 PM, Dec. 13, 1947
Date & Time of Shutdown ..... 12:30 AM, Nov. 1, 1948

Days on Stream	324
Total Hours of Run	7,761
Total Hours on Stream	7,711
Total Hours off Stream	50
Total Hours Shutdown	79
Efficiency	98.5%

The 50 hours off stream as noted in this report of the second run were required for the repacking of valves and couplings, the correction of minor electrical difficulties, the connecting in of a new cooling tower and the cleaning of the water side of flue gas steam generator.

Overall Efficiency

The combined results of both the first and second runs have been tabu-

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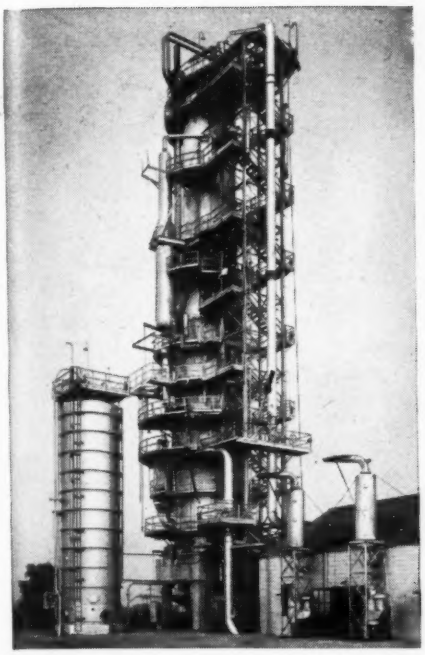

Fluid catalytic cracking unit at Detroit refinery of Aurora Gasoline Company.

lated as follows:

Total Hours, Runs 1 and 2..12,315
Total Hours on Stream 11,858
Total Hours off Stream 126
Total Hours of Shutdown 331
Efficiency 96.1%

Normal operating and maintenance personnel accomplished both turnarounds, and in both, the requirements are considered more than satisfactory. For the first, after 176 days on stream, 4,508 man hours were necessary. The second, after 324 days on stream, called for only 1,677.

Catalyst Losses Below Estimate

For a total raw oil charge of 1,405,384 barrels (average of 4,340 bbls./S.D.) during the second run, total catalyst loss has averaged .207 pounds per barrel. This figure is actually lower than the minimum estimated by the designers of the unit prior to its construction and has contributed considerably to the efficiency of our operation.

UOP Process Booklet

A 24 page booklet describing in detail the processes licensed by Universal Oil Products Co. is now available. Complete flow diagrams accompany the dicussion of each process.

In addition, the book deals with Universal inhibitors, downdraft equiflux and center-wall heaters, and the various services offered to the company's licensee refiners.

The processes discussed include: fluid catalytic cracking, thermal cracking, catalytic polymerization, paraffin alkylation, Unisol mercaptan extraction, thermal reforming, isomerization, catalytic dehydrogenation and catalytic desulfurization.

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FIELD SERVICE...

In providing adequate field service to licensee refiners, Universal contributes to the successful and economical operation of refineries in all parts of the world. It is a thorough and complete service that covers practically every phase of refinery operation and assures maximum safety, efficiency and economy. It is a service that has helped many refiners keep their operations at a profitable level.

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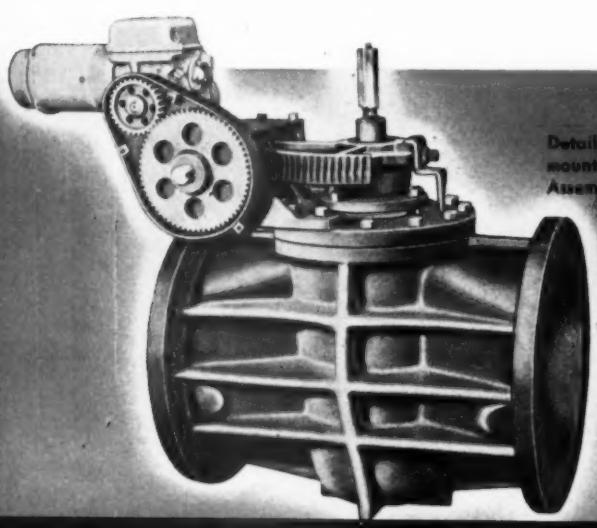
Universal Service Protects Your Refinery

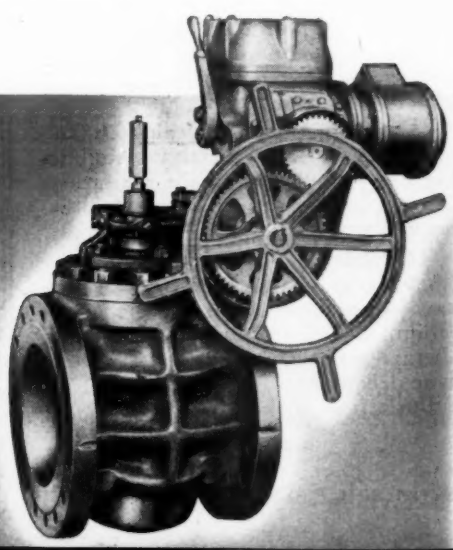
All-electric Nordstrom valve manifold controlling lines from fields to tank at Baton Rouge, Louisiana plant of Plantation Pipeline Company. Photo by Corsini, by courtesy of Standard Oil Company of N. J.

More and more the trend is toward power-operated valves. Lubricated plug valves are best suited for motor control. Minimum time is required to open or close a Nordstrom with its quarter-turn plug. There's no chance for a Nordstrom to be "not quite" closed. Positive rotary action of the plug insures full closure and a sealed circuit of lubricant hydraulically pressurized around each port. Our engineering staff will work closely with yours in developing the precise specifications to meet your needs.

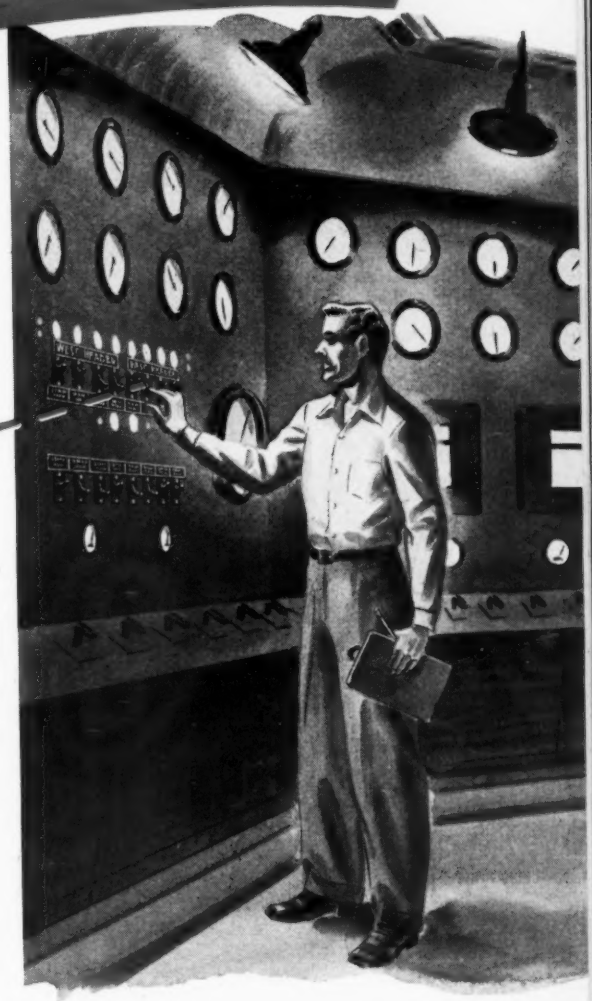


Detail of Cutler-Hammer electric motor unit mounted on Nordstrom gear-operated valve. Assembly consists of motor, reduction gears, declutching device, limit switches and contacts for controlling positions indicating lights.

Limitorque operator unit installed on Nordstrom gear-operated valve. Assembly is made at factory ready for installation on location.



REMOTE VALVE CONTROL - most modern



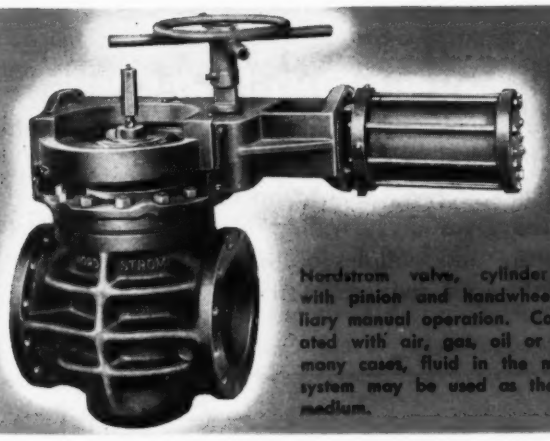
Instant, centralized control of lines

any distance ★

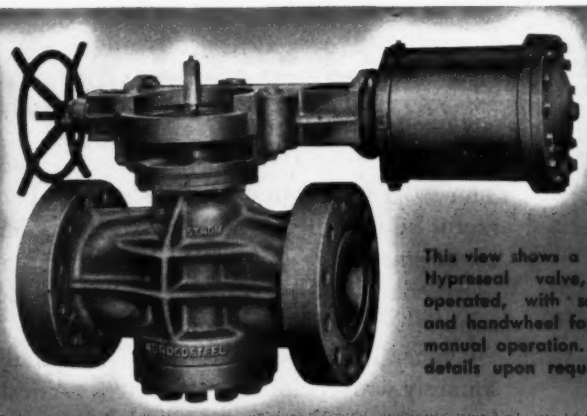
any pressure ★

any capacity ★

With Nordstrom electric motor or cylinder operated valves you can arrange control of your manifolds, pipelines and other remotely located operations independent of manual control. Standard cylinders are available for installations in which this type of control is preferable. For operating pressure ranges from 50 to 200 lb gauge pressure, complete with cylinder mounting bracket and all operative parts assembled. Nordstrom plug design gives positive closing and opening with only a quarter-turn—and the plug is permanently seated. You save man-hours and maintain instant control.



Nordstrom valve, cylinder operated, with pinion and handwheel for auxiliary manual operation. Can be operated with air, gas, oil or water. In many cases, fluid in the main piping system may be used as the operating medium.



This view shows a Nordstrom Hypreseal valve, cylinder operated, with screw stem and handwheel for auxiliary manual operation. Complete details upon request.

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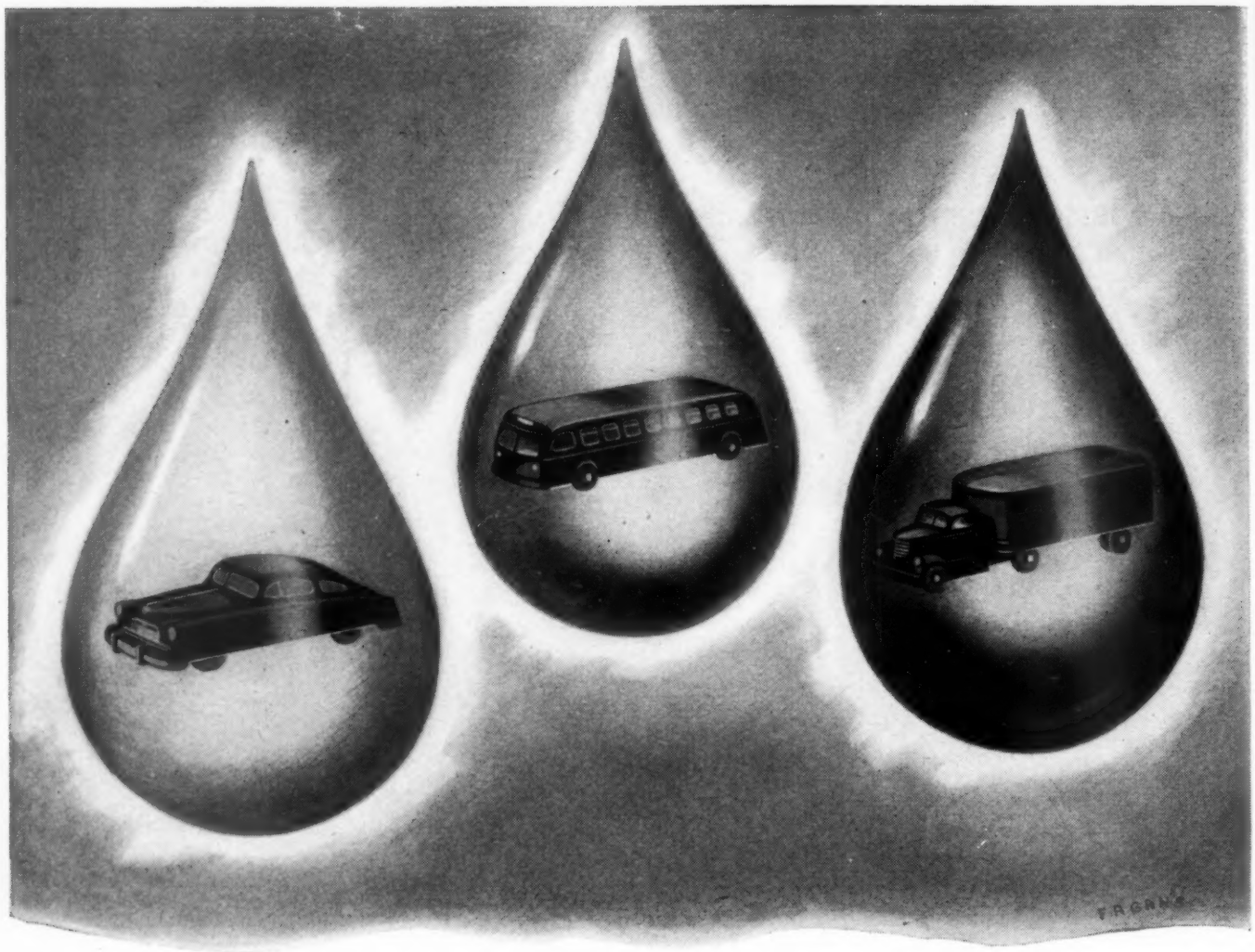

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...to increase your motor oil capabilities

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WHEN PERFORMANCE COUNTS . . . CALL ON CYANAMID

What's Happening!

Important Current News Summarized for Refiners

THROUGHPUT, 1949

Drop in runs forecast: Total crude runs to stills of about 5,620,000 b/d should be adequate for the first quarter of 1949, the Bureau of Mines has forecast. This rate may continue into the second quarter in view of the accumulation of refined stocks and the possibility that demand may be less than anticipated. Total runs to stills in December averaged 5,740,000 b/d. Demand for domestic crude of about 5,460,000 b/d is forecast for the first quarter. December demand was 5,580,000 b/d.

Refining capacity: Crude throughput capacity of U. S. operable refineries is expected to increase 3.5% in 1949, to total of 6,569,400 b/d by the end of the year, the National Petroleum Council reports. Largest increase will be on East Coast. Refineries in December were operating at 90.6% of estimated capacity of 6,346,900 b/d.

• • •

MARKETS, PRICES

The newly arrived buyer's market became more deeply entrenched during January. Its promised expansion continued to shake out prices in most areas as competition among refiners and suppliers intensified. In the southwest, crude allowables were cut an additional 3% for conservation reasons and to avert additional backing up of above-ground stocks.

Impact of declining products prices was felt in crude markets. South Penn Oil Co. and other buyers of Pennsylvania-grade crudes cut their prices 44 to 54c per bbl.—the third Pennsylvania crude reduction in six weeks. Standard of California also reported a 25c per bbl. cut in its price for 14 gravity heavy crude.

• • •

RESEARCH

More effective use of petroleum technologists in event of another war or similar emergency is a possibility seen in Army report based on case histories of 15,157 scientists and engineers in the recent war. Only 30% said their specialized abilities were used through most of their service at levels of technical responsibility warranted by their past training and experience. Around 37% said no use was made of their scientific background or training.

The report recommends a national office be established to evaluate the supply of scientific manpower in terms of current and potential needs, just as industrial facilities are being cataloged.

• • •

SYNTHETIC FUELS

Appropriation of $10,000,000 is asked by the President in his annual budget message to Congress, for continuation of Bureau of Mines research in synthetic liquid fuels. Current year's cost is $9,750,000.

Reduction in costs for plant construction and gasoline manufacturing in a hypothetical 30,000 b/d coal hydrogenation plant are cited in Bureau of Mines Information Circular 7486, demonstrating improvement in design and process modifications. Direct gasoline manufacturing cost is set at 14.3c per gal.

Petroleum refiners have been accused of "propagandizing" against a synthetic fuels industry by the United Mine Workers Journal, which states refiners are stimulating their own development work to "minimize the need for congressional funds to develop economical synthetic fuels processes."

• • •

EXPANSION

McColl Frontenac Oil Co. Ltd., subsidiary of The Texas Co., is planning a refinery at Edmonton, Alta., probably to process crude from Leduc field. Estimated cost around $10,000,000.

Shell Oil Co., Inc. to build a new refinery in Victoria, Australia, construction to take about two years.

McCarthy Chemical Co. will construct a second absorption plant at Winnie, Texas, to manufacture chemicals from hydrocarbons processed from natural gas in Jefferson and Chambers counties.

Cities Service Oil Co. plans a natural gasoline plant to handle gas produced with oil in the Chico field,

Information on these pages is obtained through the nation-wide news coverage services of PLATT'S OILGRAM NEWS

Wise county, Texas, eventual processing capacity to be 22,000,000 cu. ft.

Hi-Way Refineries, Ltd., has let contract to Refinery Engineering Co., Tulsa, for a 2000 b/d crude topping unit and 500 b/d Dubbs-licensed thermal cracking unit at Saskatoon, Sask. Present 1000 b/d topping unit will be replaced.

Magnolia Petroleum Co. has contracted with Delta Engineering Corp., Houston, for modernization of its Sabine Valley gasoline plant at Kilgore, Texas, which will make possible recovery of around 20,000 gals./day additional liquid products.

Two natural gasoline plants, each of 60-80,000,000 cu. ft. daily capacity, to cost $12,000,000 are to be built in Benedum field, Upton county, Texas. Contract for one of the plants, to be built by Plymouth Oil Co., has been let to Hudson Engineering Co., Houston. Second plant will be built by Slick-Urschel, with the Texas Natural Gasoline Corp., San Antonio, the contractor.

• • •

LEGISLATION

Tidelands: The question of control of the petroleum reserves in the nation's tidelands is before Congress and the Supreme Court, with the possibility it may develop into an issue of states rights. In the background is a hint of a possible compromise and the suggestion that President Truman favors developing the oil there, as opposed to holding it in reserve, although he emphasized that title to the oil "must be vested in the federal government."

Oil-divorcement: Sen. Gillette (D., Iowa) introduced in Congress three oil-divorcement bills in virtually the same form as the measures he sponsored unsuccessfully in the 77th Congress, in 1941. The bills, referred to the Senate Judiciary Committee, are:

S. 571, to prohibit interstate common-carrier pipelines from transporting commodities in which the carriers have any interest.

S. 572, to divorce the production, refining and transporting of petroleum products from that of marketing such products.

S. 573, to prohibit producers, refiners and marketers from operating tankers and barges.

Refining is defined in the bills as "the refining, processing or converting of crude petroleum, fuel oil or natural gas into finished or semi-finished products. It shall include the initial sale with transfer of ownership of refined petroleum products to customers at the refinery."

FPC Jurisdiction: On the question of the jurisdiction of the Federal Power Commission over the natural gas industry, Rep. Lyle (D., Texas) offered bill (H.R. 79) which would eliminate the controversial provisions of the Rizley-Moore bill of the last session relating to rate making practices of interstate gas lines. The bill would make plain the FPC has no jurisdiction over production and gathering of gas or facilities used in these activities.

Synthetic Fuels Plant Subsidy: Sen. McCarran (D., Nev.) introduced S. 6, corresponding with bills introduced in the last Congress, authorizing government loans to private industry to build synthetic liquid fuel plants with a daily capacity of at least 5000 bbls. After one year, if industry fails to establish a basis for an expandable synthetic fuels industry, government itself may contract for construction and operation of plants of aggregate 30,000 b/d capacity.

The President, in his message to Congress, asked a direct appropriation of $1,000,000 for the commercial production of synthetic fuels, plus contract and other authorizations totalling $30,000,000.

Waste Disposal: Rep. Byrnes (R., Wis) introduced H. R. 1343 to encourage prevention of stream pollution by allowing amounts paid for plants for treatment of industrial waste to be deducted in computing net income for tax purposes.

• • •

MISCELLANY

Conservation-wise, the petroleum industry in Texas is spending $250 million in a postwar gas conservation program to save nearly 2¼ billion cu. ft. daily of casinghead gas produced with oil. Hines H. Baker, president, Humble Oil & Refining Co., reporting recently on the progress of the program, said it involves building 138 plants, of which 82 are completed, 43 are under construction, and 13 are planned. Current program is projected for completion in 1950.

More than 800 German patents and patent applications in petroleum and chemical fields seized by the government during the war can now be licensed on a "conventional" basis. Taken in 1942 as the property of I. G. Farbenindustries, the patents have been in litigation in suits brought by New Jersey Standard and affiliates. This litigation was decided in the Supreme Court last spring and licensing arrangements are now completed. Lists of the patents and licensing information can be secured from Office of Alien Property, Department of Justice, Washington.

Oil and other industries will be urged through trade journal advertising to turn up 1,000,000 tons of heavy steel scrap for the steel mills. API President Boyd is on a committee to push the drive. Only heavy cast scrap—machinery, tools, jigs, dies, etc.—are sought, because greater tonnage of steel can be produced with present plant capacity with heavy scrap rather than light or mixed scrap.

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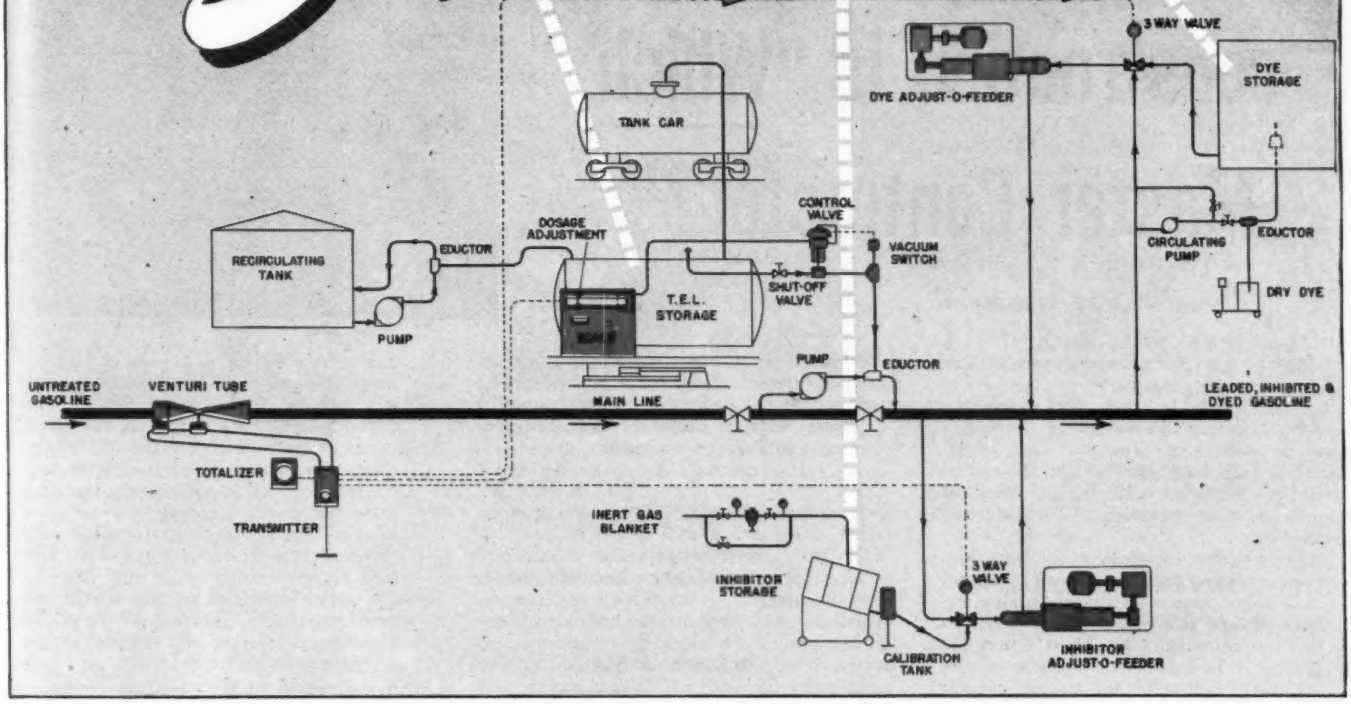
3 COSTLY ADDITIVES

LEAD

INHIBITOR

DYE



This schematic flowgram illustrates %Proportioneers% Treet-O-Control method of regulating lead, inhibitor and dye injection to a flowing stream of gasoline from a low loss Venturi differential producer.

Additives are handled in concentrated form and are taken directly from the containers in which they are shipped. Transfer of the lead fluid is made from tank car to weigh tank through a vacuum eductor system.

This %Proportioneers% Treet-O-Control system eliminates pre-dilution requiring tankage, piping, circulating pumps and other accessories. It requires minimum space for equipment and assures maximum accuracy in the handling of costly additives.

Ask for further information and recommendations.

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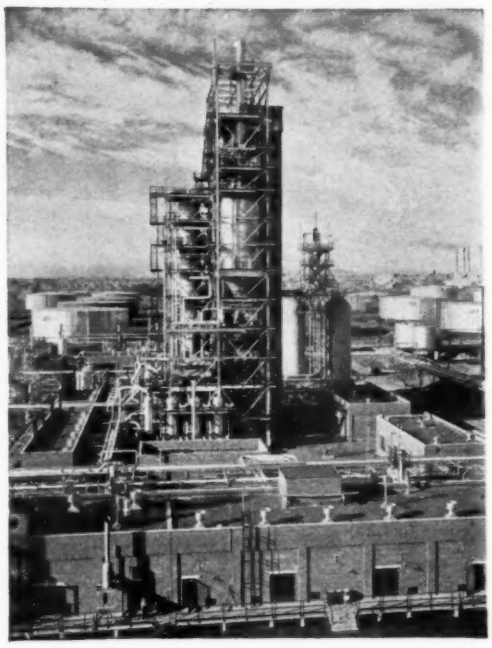
Technical service representatives in principal cities of the United States, Canada, Mexico and other Foreign Countries

The important question in foreign refinery construction is "Which Master Contractor?"



GREAT pressure for refinery expansion and refinery modernization is now being felt in foreign fields, where both a ten year hiatus in building and major war destruction must be overcome. The new capacity required is large and presents serious capital outlay problems to both foreign national refiners and foreign subsidiaries of American companies.

The *master* contract type of operation, concentrating all engineering, material procurement and construction responsibility at any one refinery site in one organization's hands, is especially desirable in this work because of the inherent potential for major capital savings which has been established previously in this series.

Thus, the question facing refiners undertaking projects for installation outside the United States becomes not *whether* to use the *master* contract type of operation but, rather, *which* "master" contractor to engage. To clarify consideration of this latter question, Kellogg presents what it believes to be the most important factors which should be taken into account when selecting a *master* contractor for foreign work.

First, it would appear most important to select an engineer-contractor that has had repeated experience with the multitudinous responsibilities of varied types of *master* contract operations and naturally a successful record.

Further, the contractor's *existing* establishment, in manpower and resources, should be capable of handling the entire project both expeditiously and efficiently *within his own organization.*

Second, this contractor should have had experience in *foreign* operations—not necessarily at the particular location of the proposed job, but most assuredly at a sufficient number of foreign locations so that the contractor's organization shall have learned *previously* the many unusual, and in many respects more difficult, requirements of foreign operation.

Third, the contractor's design groups—laboratory, process and mechanical—should have a *secure and unquestioned engineering reputation,* eliminating any desire or need to build "monuments to advanced processing" for prestige purposes, when such refinements are not justified by immediate and specific economic need. In short, the contractor's engineers should be mentally conditioned to approach the planning of each project on one basis only—*to design facilities which will meet the immediate and foreseeable market demands and in so doing earn the most pesos, cruzeiros, dinars, pounds, or francs over a period of years for the least immediate capital outlay.*

Fourth, under present world supply conditions, the contractor's ability to perform effectively the complex and difficult *task of procurement* of materials and equipment will prove critical in accelerating the on-stream date of the plant. Maximum speed and final economy in the conduct of this responsibility requires three basic capabilities: An existing procurement group *large* enough and *experienced* enough to purchase, inspect and expedite with thoroughness and dispatch the thousands of items of material and equipment which comprise a major refinery project; an *up-to-the-minute detailed knowledge of world-wide sources of supply,* which can be maintained only through active purchasing activity carried on constantly over the years in the major markets of the world; together with the "know-how" to utilize local currencies to the utmost in the procurement phase.

Fifth, the contractor must be capable of putting into the field when construction begins, *a quality of field supervisory and technical personnel equal to the magnitude of the task* . . . men accustomed to handling large-scale field administrative problems equivalent to those of a small city . . . men equipped by education, training and experience to solve problems in the field without need for reference to home office rulings and engineering advice.

Experience **is the basis for this evaluation of the major considerations to be resolved by any refiner undertaking refinery construction outside the United States. *Experience* that has paralleled the growth of the refining industry, extended over a period of some thirty years, and embraced refinery projects of all kinds in practically every corner of the globe. It is *experience* that is further substantiated by foreign contracts currently entrusted to Kellogg totalling more than a hundred million dollars embracing *21 separate projects in Argentina, Belgium, Brazil, Canada, France, the Middle East, the United Kingdom and Venezuela.***

BENNETT ARCHAMBAULT
Treasurer
In Charge of Foreign Contracts
The M. W. Kellogg Company

Our company—M. W. Kellogg—is completely staffed and equipped for refinery and chemical plant design and construction, from the step of laboratory research through the initial operation of completed plants. It periodically issues a publication called the KELLOGGRAM, which describes many of these services. If you are not already receiving it, we will be glad to add your name to the list if you will drop us a line at 225 Broadway, New York 7, N. Y.

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Tomorrow

. . . IN PETROLEUM TECHNOLOGY

Brief reviews of currently reported technological and economic developments, in the light of their potential bearing on petroleum refining

Mines Bureau Reports on Oil In Bituminous Limestones

URING THE RECENT war, the U. S. Bureau of Mines conducted research on the separation of hydrocarbons from surface deposits of bituminous limestones of the type found near Edna, Calif., in the San Luis Obispo region. This area alone is estimated to contain 282,880,000 short tons of bituminous material at depths not greater than 250 feet and not covered by more than 50 feet of overburden. On the basis of approximately 0.5 barrel (26 gallons by analysis) of bitumen per ton, the deposit contains 141,440,000 barrels of bitumen,(1) it is stated.

The hot-water process employed consisted, broadly, of three operations:

1. Heating and mixing the bituminous sandstone with water and enough alkaline reagent to form an alkaline pulp, in which the bitumen is displaced from the sand grains by the water. Efficient separation also depends on the occlusion of enough air in small bubbles in the pulp to form an oil froth.

2. Separating the oil froth from the sand by submerging the pulp in hot water. The oil froth floats on the surface of the water, and the sand grains, freed of bitumen, sink to the bottom.

3. Removing the water, sand, and silt from the oil froth by dilution of the bitumen with a light oil, and settling.

Many factors are involved in these steps which, however, were not carried into the pilot-plant stage by the Bureau of Mines, hence "do not permit estimates to be made of separation costs." The process is similar to (and based upon) work done upon Alberta bituminous ("tar") sands.

Experiments on product derivation from the separated bitumen indicated that motor fuels, Diesel fuels, and fuel oils could be prepared from the separated bitumen by various cracking processes, as could also coke and asphalt; hydrogenation was apparently not employed. Typical gasoline yields from two experiments using mild cracking were 7.0% and 17%; gas oil yields were 21% and 20%; yields of No. 5 fuel oil were 19% and 21%; and yields of residuum were 50% and 40%. Cracking to coke gave the following yields (weight %): 70.7% liquid, 22.6% coke, 6.7% gas. The liquid so obtained contained 19.4% gasoline, 26.7% gas oil, 53.9% No. 5 and No. 6 fuel oils. Lubricants could be obtained from the appropriate fractions.

(1) G. B. Shea and R. V. Huggins, *Laboratory Study of the Hot-Water Process for Separating Hydrocarbons from Surface Deposits of Bituminous Sandstones Near Edna, California*, U. S. Bureau of Mines R. I. 4246, 1948. 31 pages.

Antifreezes Subject of Standards Bureau Booklet

AS POINTED OUT LAST MONTH in PETROLEUM PROCESSING(2) some petroleum companies are now much interested in manufacturing antifreeze materials from petroleum as well as in selling the finished products to automobile drivers.

The average automobile driver, however, is not particularly interested in who makes his antifreezes, other than as he is swayed by "brand" advertising. He does evidence a growing preference for the "permanent-type" but even here he is confused as to the constituents and the basic difference (if any) between the products of various manufacturers. To alleviate this "ignorance," numerous leaflets have been distributed by reputable antifreeze manufacturers and others. The best of these, "intended primarily for the average automobile owner," has long been a booklet issued by the National Bureau of Standards, a new edition of which(3) is particularly timely.

One purpose of this new edition, according to advance reports, is to warn motorists, again, against the use of salt-base and "petroleum" antifreezes and coolants by reporting use tests and their disastrous results. Even highly refined petroleum coolants (kerosenes) attack most radiator hose (except that made from certain synthetic rubbers which, however, are used only to a limited extent for this purpose). Inflammability is also a problem, although this hazard is not a serious one as regards incidence of fires. Engines using petroleum coolants run hotter, because of the smaller heat capacity of these materials; the octane requirements of present-type automobiles are increased 7.5 units by their use.

(2) B. H. Weil, "An Expanding Market—Antifreezes from Petroleum," PETROLEUM PROCESSING 4, No. 1, 43-46, 48, 49 (1949).

(3) D. B. Brooks and Ronald E. Streets, *Automotive Antifreezes*. National Bureau of Standards Circular 474, Superintendent of Documents, Washington, 1948.

Survey U. S. Industry's Research Requirements

AS A RESULT of its second annual survey of the research requirements of American industry, the Evans Research and Development Corp. reports:

(1) the government preparedness program will have no immediate appreciable effect on research,

(2) increased research appropriations will be based, for the most part, on expansion of present business activities rather than on re-armament,

(3) most companies are concentrating their activities on product and process improvement and the development of new products in fields with which they are already familiar,

(4) most firms are not making any immediate plans to increase their research activities (in the previous survey, 73% planned to increase research appropriations),

(5) a majority of companies have the capacity to accommodate new research without being overcrowded or undermanned,

(6) no shortage is expected in experienced research personnel,

(7) more than half of industry employed outside research during the past year, with commercial laboratories receiving a majority of the business, and

(8) of those who plan to increase their research activities, slightly over half will expand their own facilities, while the rest will both expand and use the services of an outside laboratory.(4)

Comparatively little divergence from industry in general is seen for the oil companies except that they depend to a greater extent upon their own research facilities exclusively; are more fearful of a shortage of experienced research personnel; base plans for expansion on the re-armament program, and plan to increase

(4) Anon., *Second Annual Report on the Research Requirements of American Industry*, Evans Research and Development Corporation, New York, 1948. 4 pages.

their own research facilities rather than depend partially on outside research organizations.

The results of this survey are not unexpected, even though they are based on answers from only 19% of the "2,467 business executives and research directors" queried. Research activities have been increasing at a record pace in recent years, and it comes as no surprise that industry is pausing for breath—while it squints at prospective profits—before continuing.

Lubricant Reclaiming At Accelerated Pace

THE RECENT DECLINE in the price of petroleum lubricants may dampen some of the enthusiasm of the proponents of the reclaiming (re-refining) of used lubricants. However, this does not alter the fact that here is an industry which has grown up without the oil companies' blessing but which nevertheless continues to grow.

Lubricant re-refining is "old"; as formerly practiced it was considered unsound and unsafe by petroleum refiners. Now, however, some of these "outside" operators, borrowing rigorous refining processes from the petroleum industry's stock in trade, turn out products which pass every test (including safe use) for original petroleum lubricants.

Large consumers of oil, including the Armed Forces, are leading the way in the reclaiming of used lubricating oils. Numerous fleet operators, railroads, and airlines have installed their own equipment, and, while some of these plants are not as good as might be desired, many are efficient miniature refineries. In large cities or other strategic localities, re-refining plants have been erected which gather used lubricants, process them, and sell the reclaimed oil on the open market, or service customers who do not choose to reprocess their own oil.

One fourth of the lubricants used monthly in this country by the Air Force is said to constitute reclaimed oil, and the Army is moving to keep step. Neither group, apparently, plans to re-refine its own oil, the work being done on a contract basis by various re-refiners.

Cost figures and statistics in this field are elusive, although *Business Week*(5) states that "cost of the laundered lubricants runs around 20 cents a gallon" and estimates the 1948 production at "almost 1,000,000 barrels of high-grade lubricating oil." According to this source, 11,900,000 barrels of used lubricants annually "go down the drain." Biggest customers are said to be jobbers "who peddle it (reclaimed oil) through retailers to the motorist and farmers. When it is marked as reclaimed oil, it retails at between 10 and 15 cents a quart."

Some re-refiners, however, command good prices for their "premium" reclaimed oils, since they add lubricant additives (anticorrosion agents, antioxidants, detergents, etc.) to their better stocks. By careful segregation of stocks according to source, they can control their product viscosity and other properties, which is of real importance to quality. While it is reported that "re-refiners get their oil mainly from filling stations" and that "they pay anywhere from 1-7 cents a gallon—depending on quality and quantity and whether they make their own pickups," other reclaimers prefer to depend on fleets, railroads, airlines, etc., since the basic material is more uniform in properties from such sources.

One re-refining plant, that of the Quality Refining Co., has recently been described in some detail.(6) This plant, while minuscule by petroleum industry standards, employs a series of steps said to yield quality products. Used oil is treated in stainless steel tanks with 66° sulfuric acid (approximately one gallon per 100 gallons of oil for an average operation), agitated, and allowed to settle. The supernatant oil is pumped into further settling tanks, then mixed with 30-40 pounds of activated clay per 100 gallons of oil.

After agitation, the charge is pulled into a still and heated to 600° F. under a vacuum of about 25 inches at the top of the run. Steam is also added to help strip off fuel dilution and cracked products. The charge is cooled by heat exchange, 10-15 more pounds of activated clay are added, along with about eight pounds of filter aid and one or two pounds of lime (to remove any remaining traces of acidity), and the batch is then processed through a plate and frame filter press.

Much more will certainly be heard about lubricant re-refining. The petroleum industry, apparently, produces a product which, while contaminated, does not necessarily deteriorate in use, and many are awakening to the possibilities inherent in this fact. If sound processes are employed, reclaimed lubricants can be as good "or better" than the original oils. If inadequate methods are used, the oils can conceivably do much damage in use. In any event, the lubricant re-refining industry is growing to be a new branch, child, cousin, or what-will-you to the petroleum industry.

(5) Anon., "Low-Cost Laundered Lubricants," *Business Week*, No. 1002, 56-58 (1948).

(6) H. D. Geigerman, Jr., "The Re-Refining of Used Lubricating Oils," *The Research Engineer* 1948-49, No. 4, 5-8, 18-20 (1949).

Detergency Is Defined In Industrial Booklet

PETROLEUM INDUSTRY INTEREST in synthetic detergents continues to grow at an accelerated pace, so it is with appreciative attention that those particularly involved have scanned a handsome booklet(7) recently published by one of their competitors. Devoted to all phases of surface activity, this publication defines the terms employed, the types of agents, and principal uses, presenting valuable data on methods of choosing a surface active agent. Emphasis, of course, is put on Atlas surface active agents, whose properties are defined and whose industrial, insecticide, detergent, and textile processing uses are given in much detail. Many of the Atlas surface active agents, incidentally, are derived from petroleum chemicals, being "alkalene oxide" derivatives.

As defined by Atlas, the principal uses of surface active agents are emulsification, dispersing, solubilizing, wetting ,detergency, foaming and antifoaming, and demulsification.

"The assisted removal of dirt or soil from surfaces, as typified by washing with an aqueous solution of a detergent, is a complex procedure. A brief summary of the probable action of detergent solutions would include the following influential factors, in the order of their occurrence in the process:

"1. Decreasing the interfacial tension between the detergent solution and the surface soil (including oil, grease, or compacted dirt). The soil is wet, penetrated, and loosened by the solution.

"2. Solubilizing soil in the detergent solution. This factor is not always involved in detergency, but is important with certain types of soil, particularly in the removal of some stains.

"3. Emulsifying and deflocculating the soil in the detergent solution. This phenomenon occurs in practically all types of cleaning operations. Oils, greases, and wax-like materials are emulsified to form semi-stable dispensions. At the same time, the insoluble oil particles are dispersed in the solution.

"4. Preventing the redeposition of the soil by the detergent solution. This is one of the most important functions of a detergent in all cleaning operations. It simply means that the dispersion of the soil is sufficiently stable to permit removal by rinsing. If the redeposition of the soil is not prevented by the detergent, all that is accomplished is a redistribution of the soil."

(7) Anon., *Atlas Surface Active Agents*, Atlas Powder Company, Wilmington, Delaware, 1948. 74 pages.

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When you seek a specific quality for your motor lubricant, turn to Monsanto Oil Additives. Each is a specialist, developed to do a particular job. Each is dual tested, in the laboratory and in actual service. Often, Monsanto Oil Additives give you a price advantage as well as superb performance of your lubricant. This is the Monsanto line:

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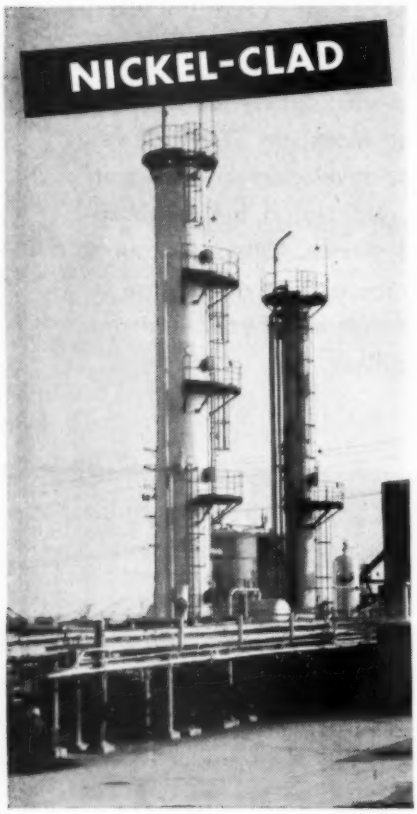

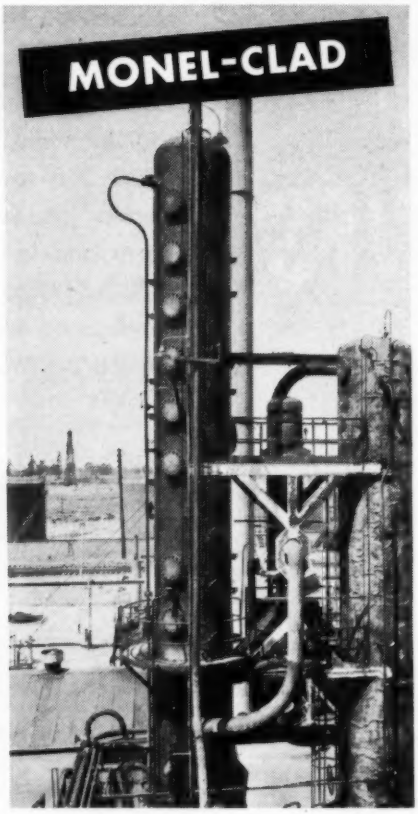

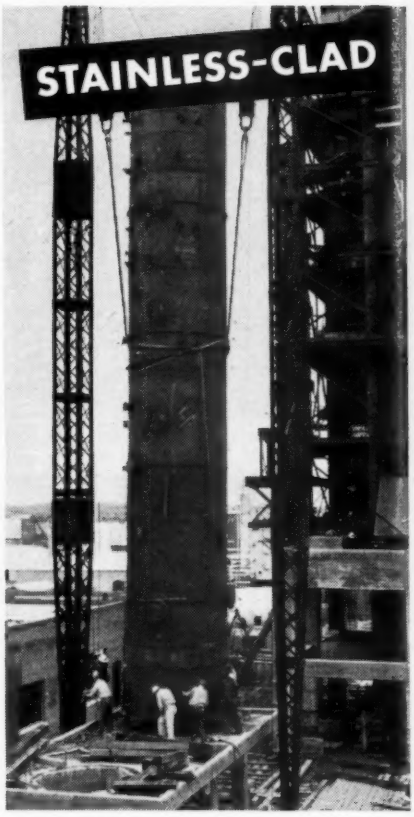

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Where equipment is subjected to one type of attack at one point and other corrosive conditions at another, different types of clad steels are employed in those sections. For example, Lukens Monel-Clad and Stainless-Clad Steels frequently team up in fractionating towers to defeat corrosive attack.

Lukens makes Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad Steels in plate to over 3 inches thick or to as wide as 178 inches. Bulletin 461 shows applications in the Petroleum Industry. For a copy, write Lukens Steel Company, 443 Lukens Building, Coatesville, Pennsylvania.

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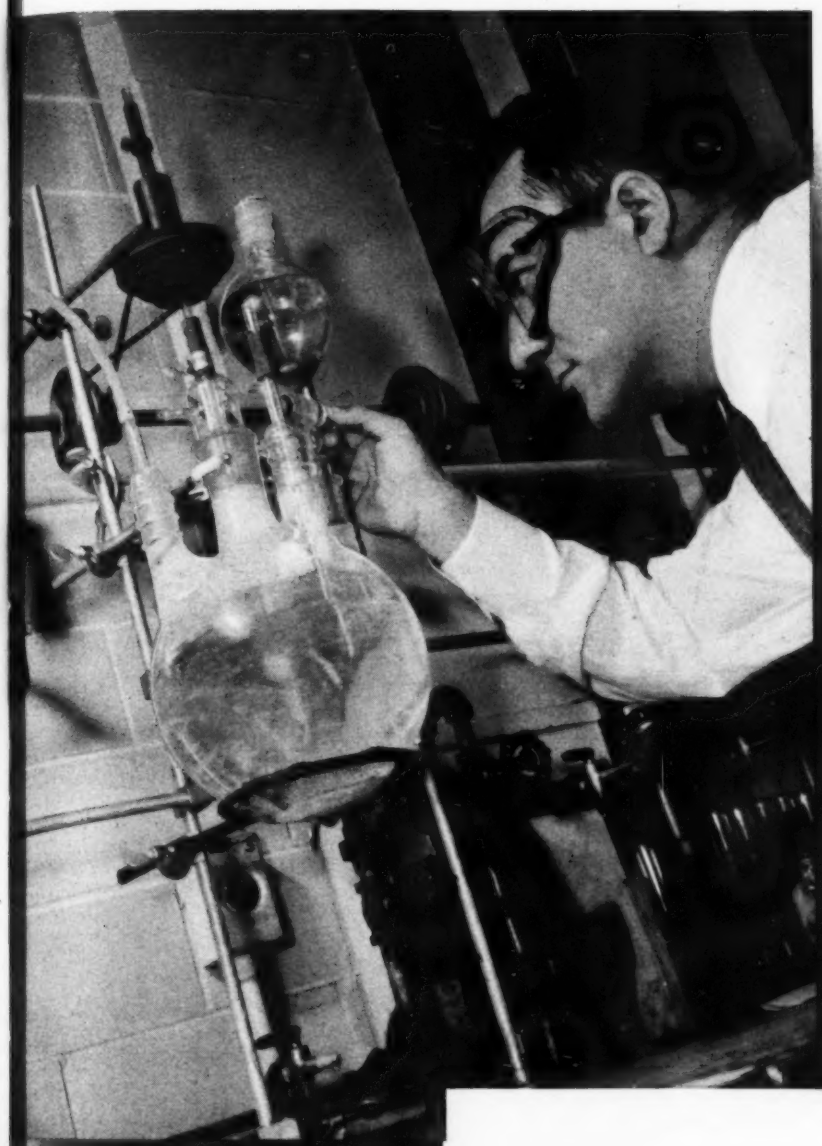

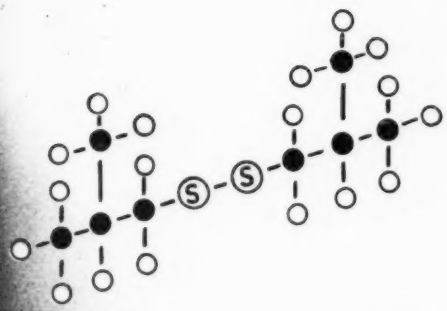

Du Pont Research

at Work on the Problem of Sulfur in Leaded Fuels

To understand better the mechanism of the anti-knock action of tetraethyl lead, and to improve the efficiency of its use, Du Pont has undertaken a broad program of research. Among the problems being studied is an investigation into the effect of sulfur compounds upon the octane number of leaded fuels.

It has long been known that sulfur, even at the relatively low concentrations that occur in present day motor fuels, causes a significant reduction in the octane number of gasolines containing tetraethyl lead. However, the chemistry of the effects of sulfur compounds in leaded fuels has not been well understood. The many phases of this problem are being thoroughly investigated, applying chemical experience acquired over many years.

This is another example of Du Pont working to help the petroleum industry produce better petroleum products at the lowest possible cost.

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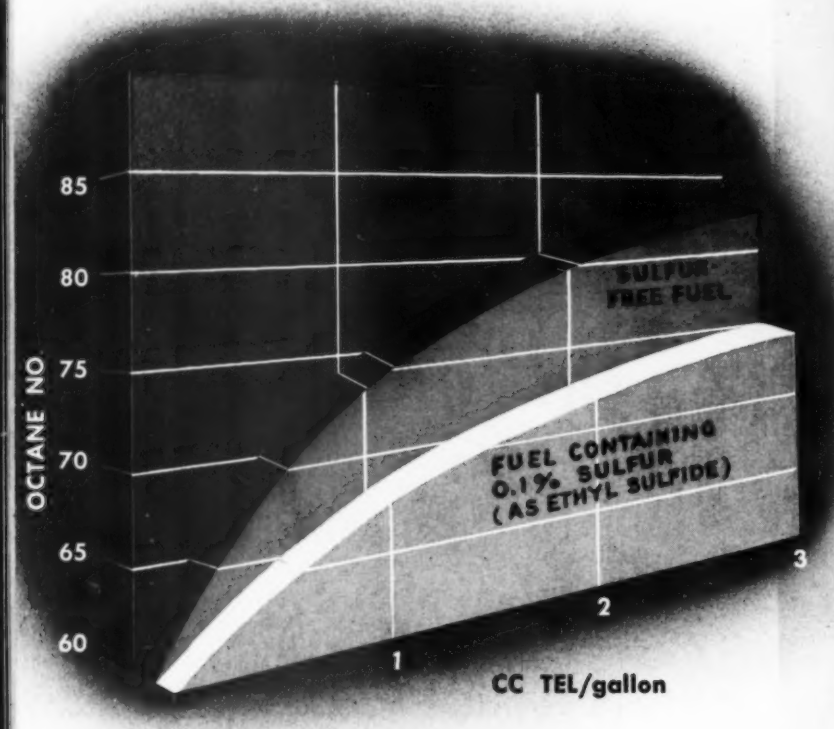

CHART SHOWING EFFECT OF SULFUR ON TETRAETHYL LEAD EFFICIENCY IN A 60 OCTANE REFERENCE FUEL

Among the problems of vital concern to the refiner is the improvement of tetraethyl lead efficiency in gasolines containing sulfur compounds. While the effect of sulfur on octane number in non-leaded fuels is insignificant, in leaded fuels it is pronounced and the chart graphically illustrates this.

Tetraethyl lead efficiency in sulfur-containing fuels can be improved by reducing the sulfur concentration. The efficiency of TEL is also dependent upon the type of sulfur compounds present, some having a more adverse effect on octane number than others. Du Pont research is working toward a better understanding of the anti-knock action of tetraethyl lead in the presence of sulfur, as well as improving the efficiency of TEL's use.

The first of a series of technical papers on the subject of sulfur in leaded fuels, prepared by Du Pont research men, entitled "The Effect of Sulfur Compounds on Octane Number of Leaded Fuels—Part 1" is now available. Write the nearest District Office for your copy.

DU PONT

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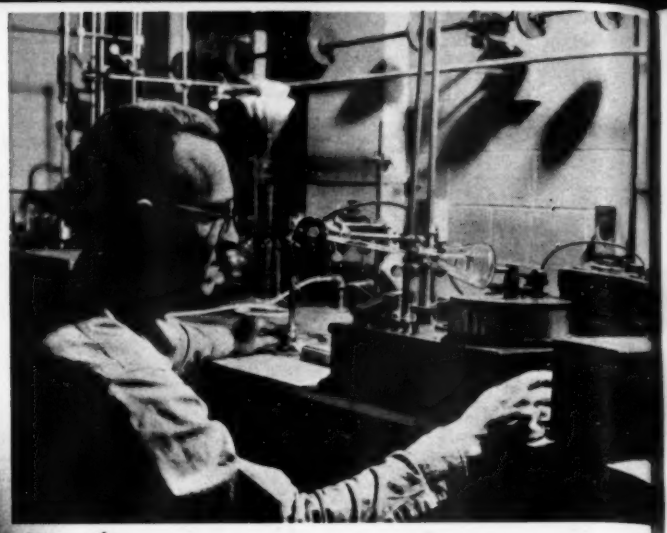
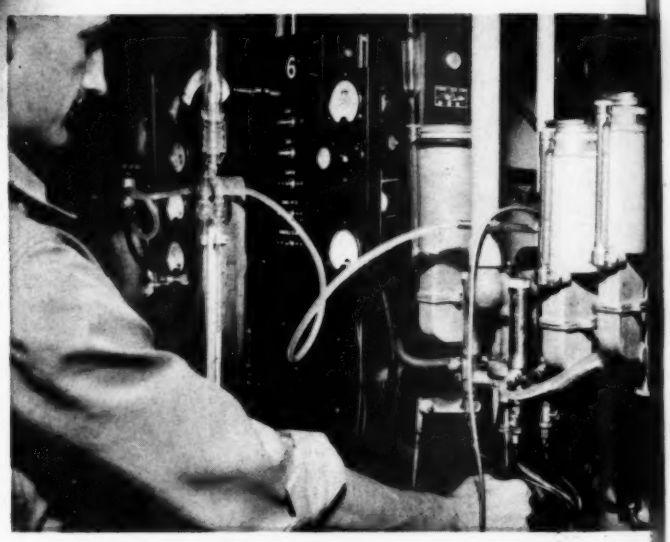


▲ Apparatus used for laboratory experiments on sulfur.

▼ CFR engine equipped for special tests to study effect of sulfur on octane number.



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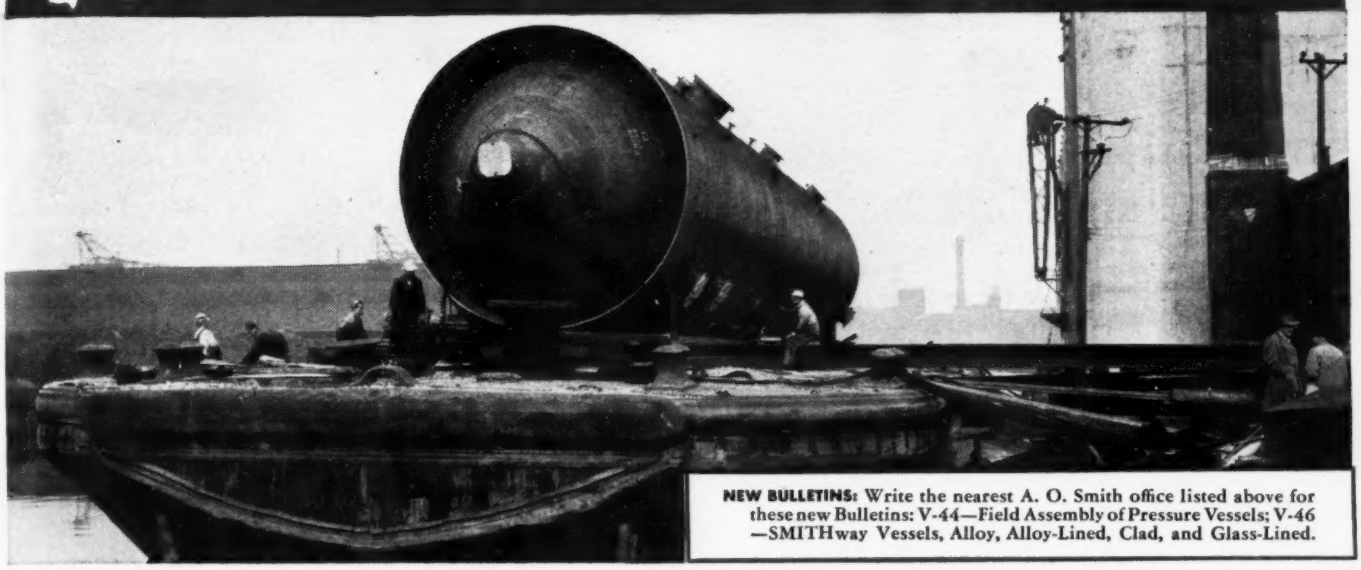
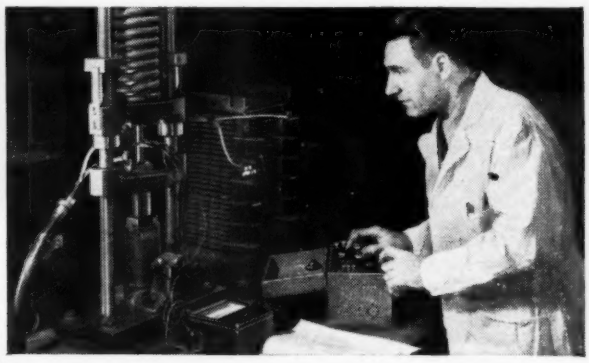


NEW BULLETINS: Write the nearest A. O. Smith office listed above for these new Bulletins: V-44—Field Assembly of Pressure Vessels; V-46—SMITHway Vessels, Alloy, Alloy-Lined, Clad, and Glass-Lined.

BY WATER AND RAIL, A. O. Smith ships pressure vessels for the petroleum, paper, and process industries. The SMITH-lined Fractionating Tower above, one of the largest shop-fabricated vessels ever built (16 ft. diameter by 116 ft. long, weighing over 320,000 lbs.), is going by barge to an oil refinery in the Chicago area.

SOME 60 SMITHway PRESSURE VESSELS for both low and high temperature service have been ordered during the last four years by one company to equip two new plants. This SMITHway Tower, three railroad cars long, 116 ft. by 7 ft., weighing 137,000 lbs., is one of the types of vessels furnished.

THIS MAN KNOWS HIS CURVES: For 23 years, Frank Hilke has been shaping, to exact diameters, the shell courses of SMITHway Pressure Vessels. He uses a variety of rolls which can produce any diameter needed for pressure vessels.



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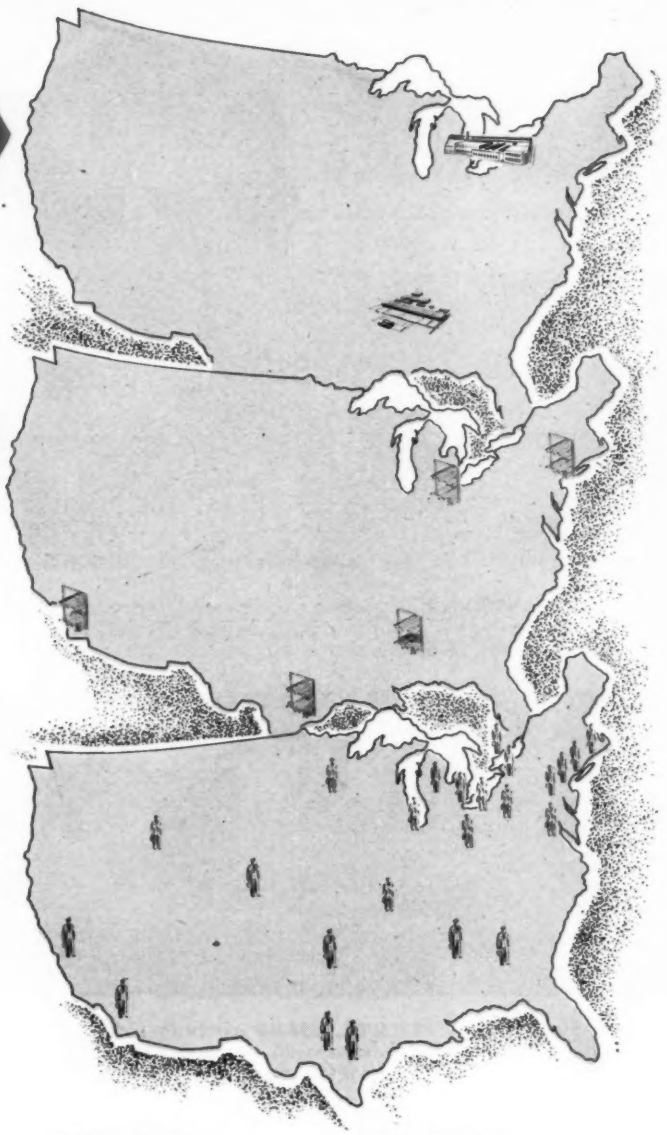

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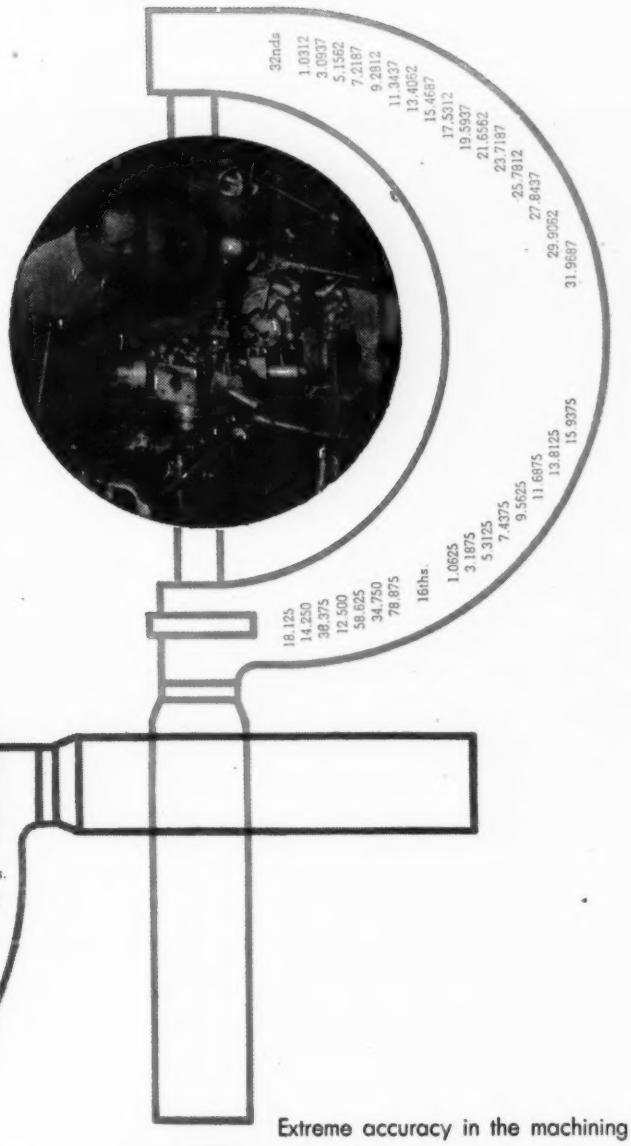

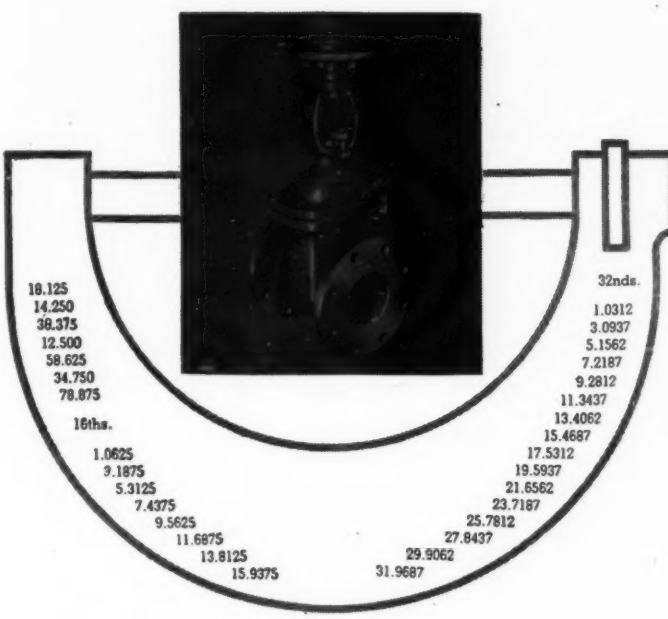

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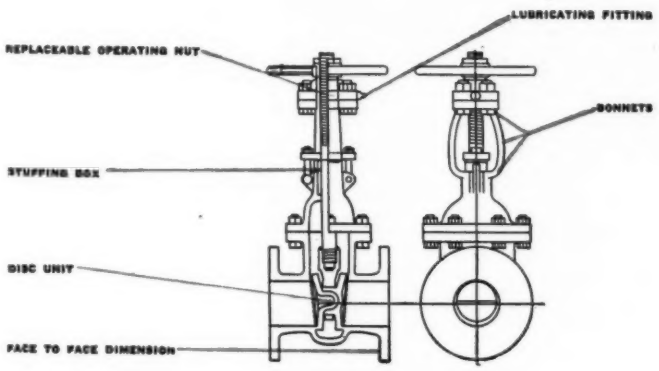

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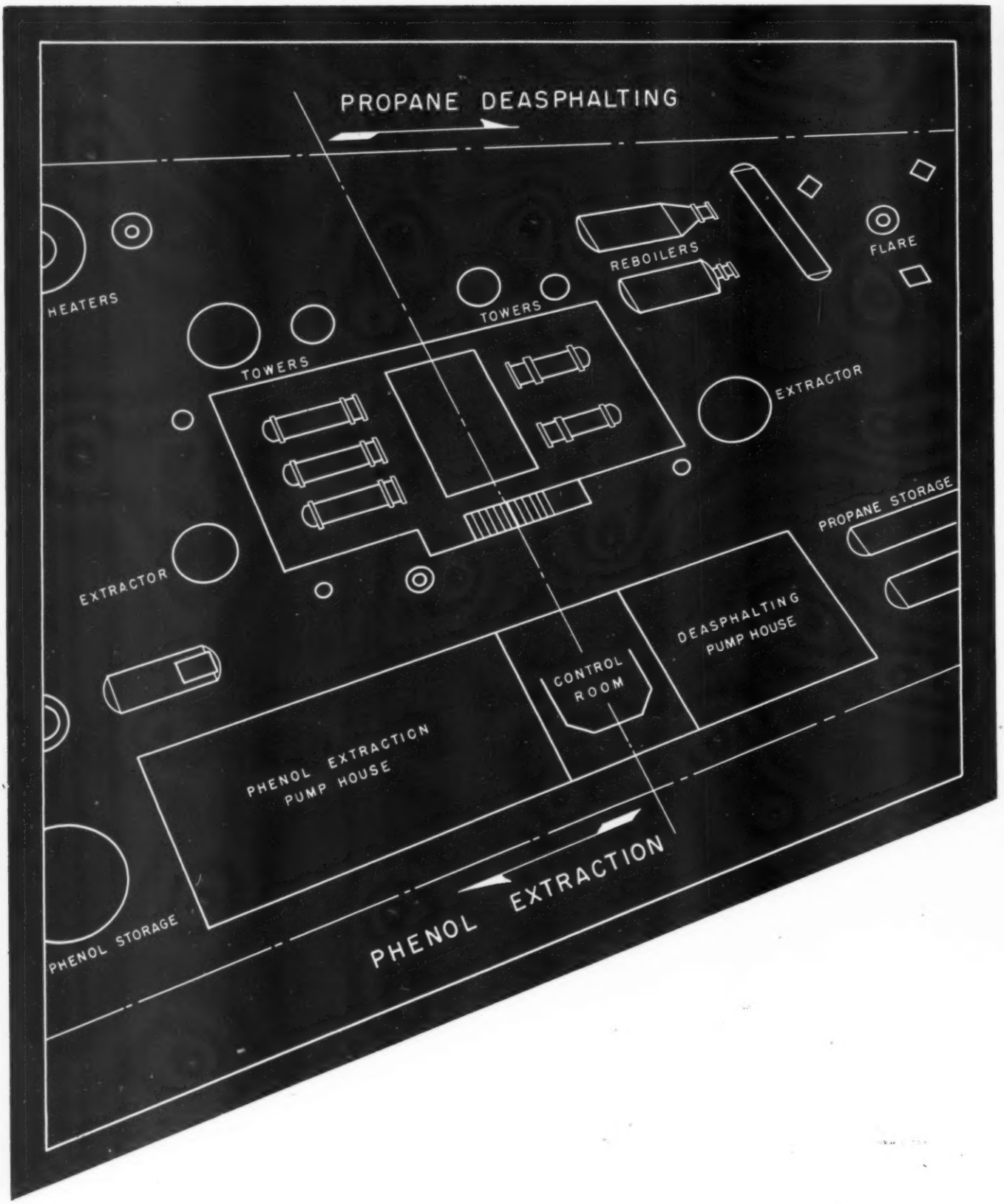

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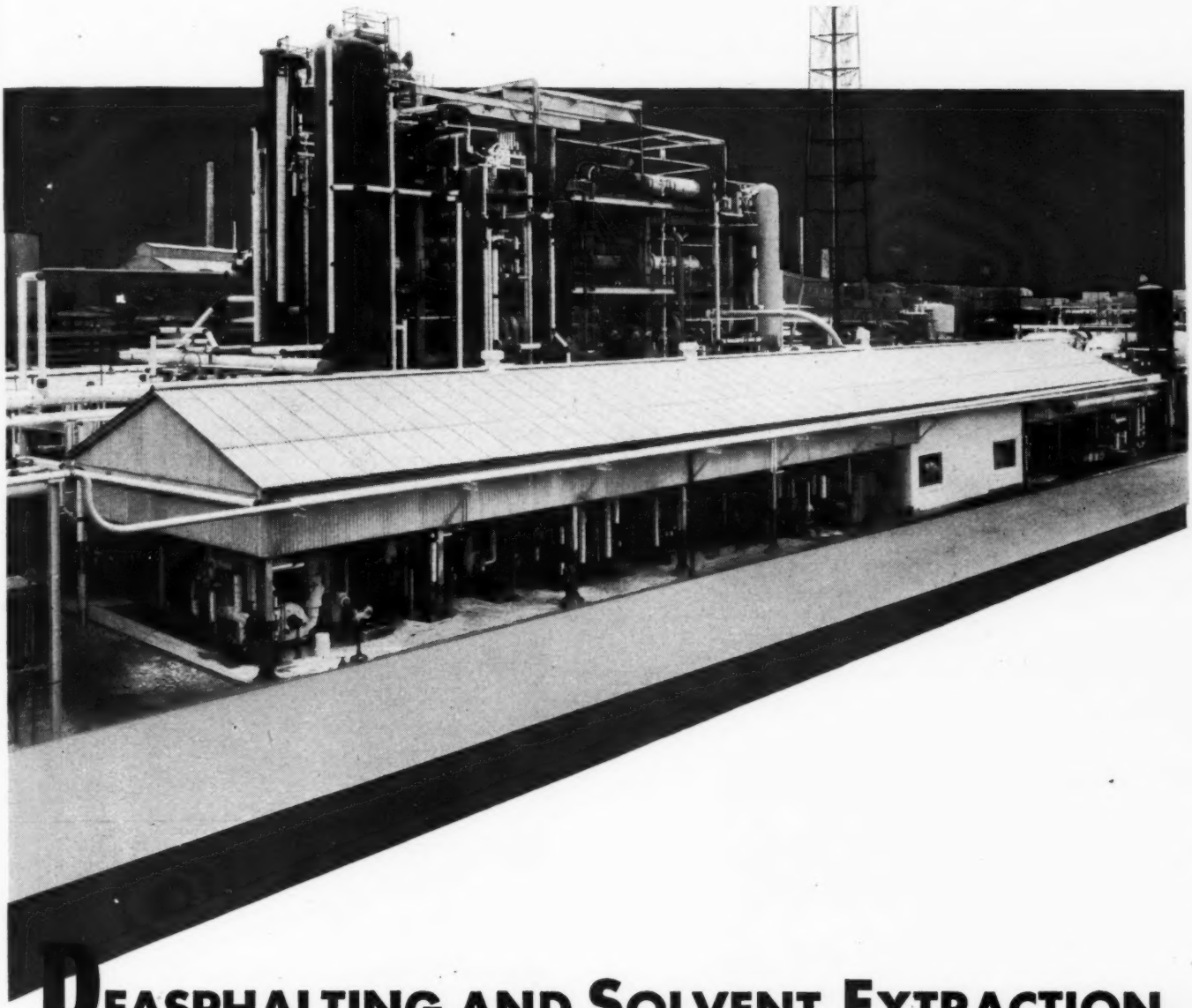

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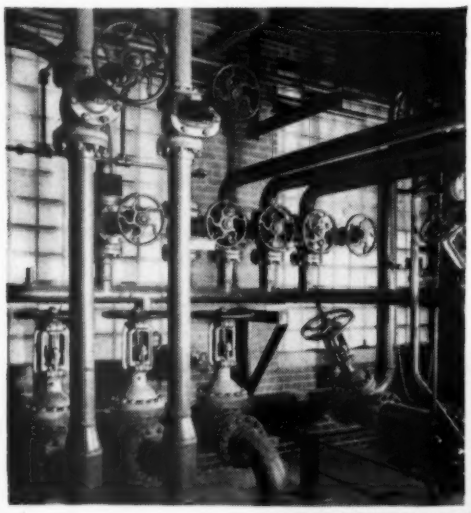

Crane 4 and 6-inch 300-pound cast steel gate valves on lines to pump-out pump in pump room of vapor recovery unit.

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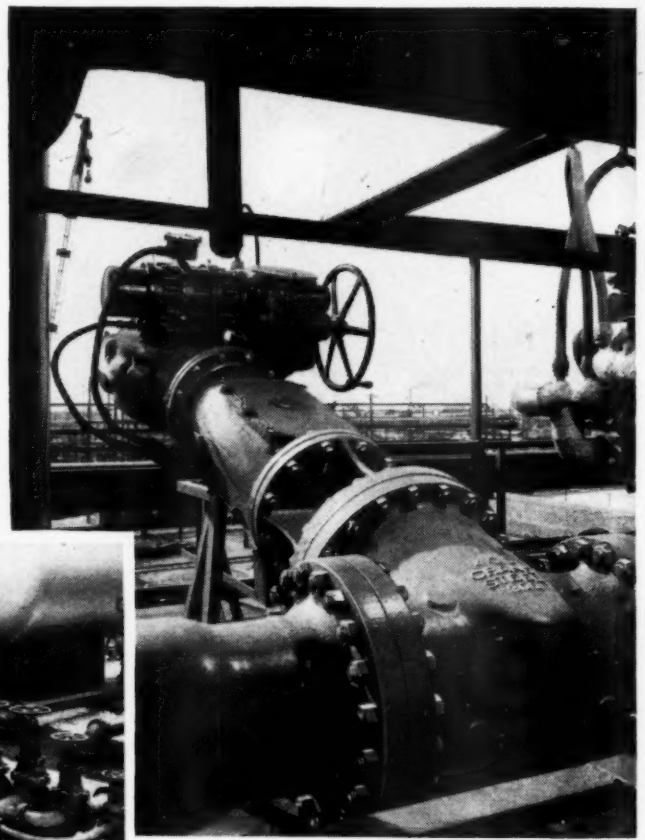

Crane 14-inch, 300-pound, motor-operated gate valve on gas line atop compressor house at catalytic cracking unit.

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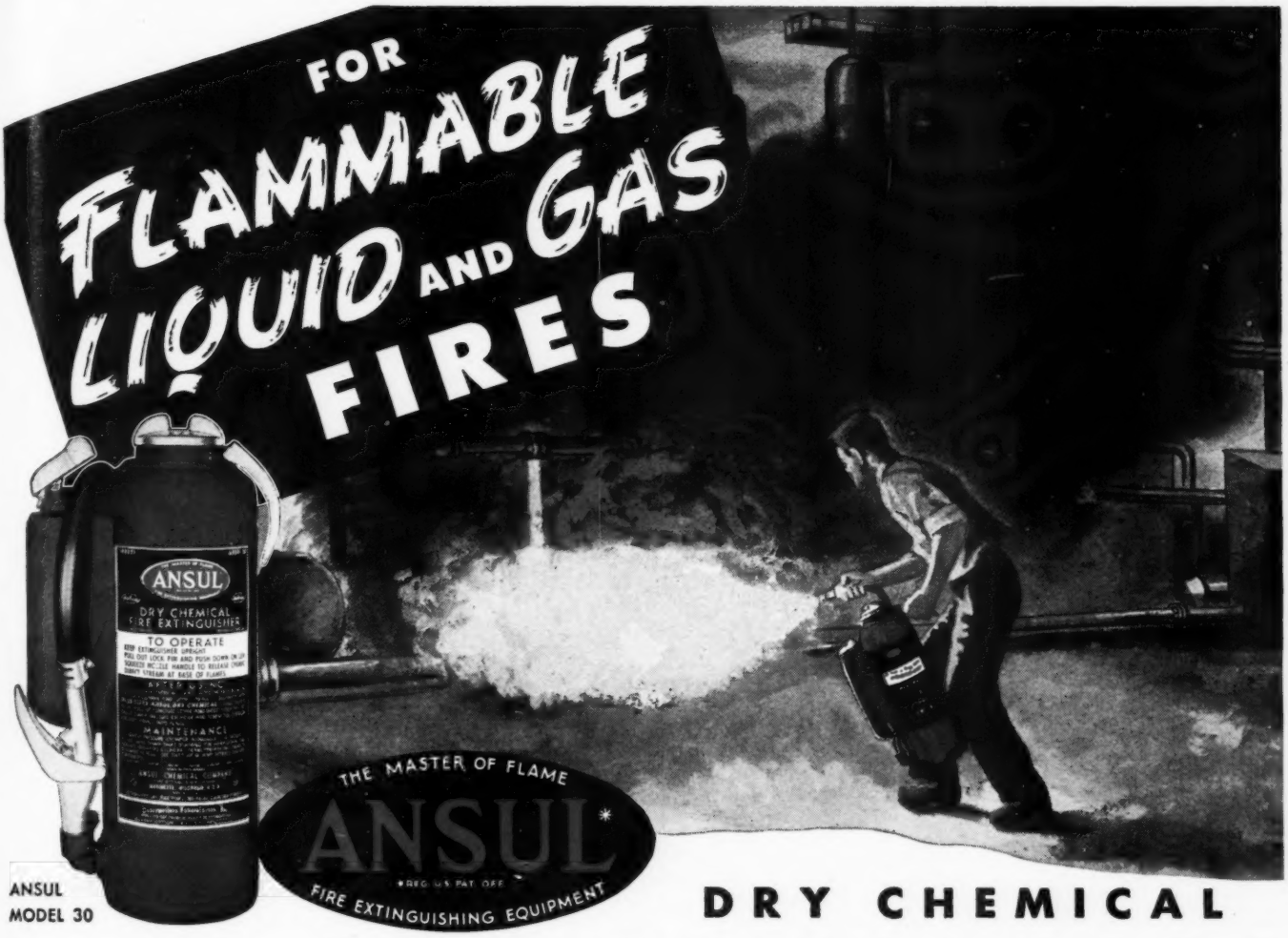

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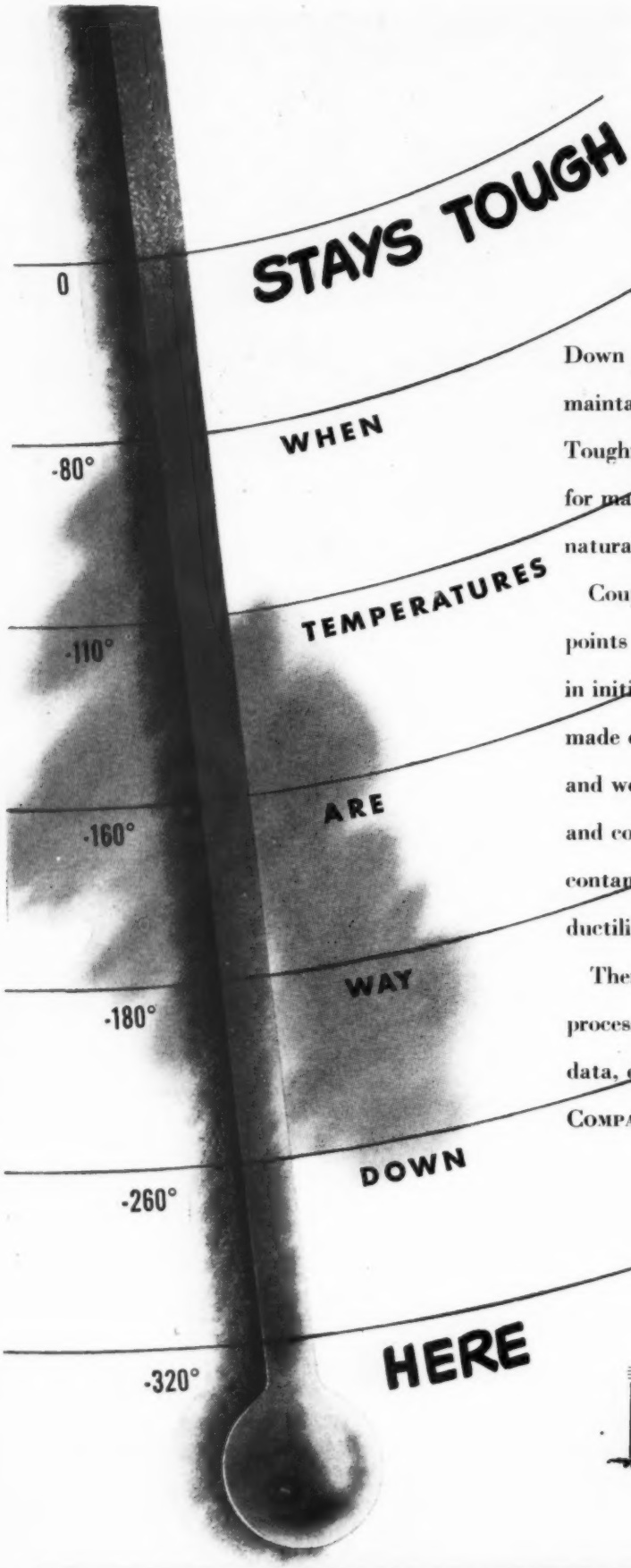

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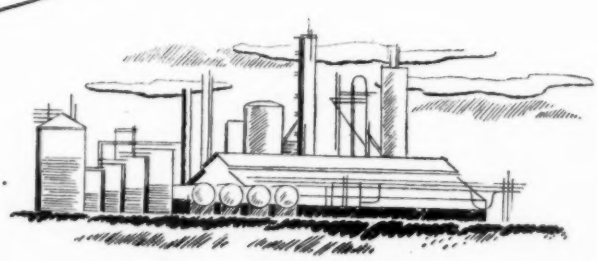
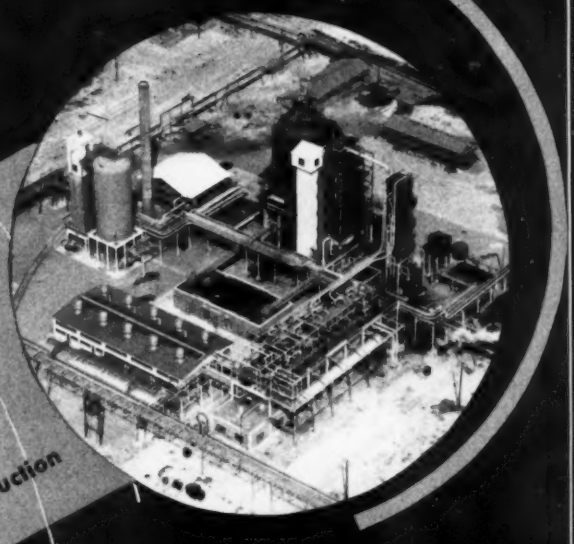


ALCOA FIRST IN ALUMINUM

ALCOA ALUMINUM

many brains are needed



process design
mechanical design
drafting
estimating
purchasing
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fabrication
construction

. . . and many brains—many functions—many details must be coordinated in the production of a process unit, a petroleum refinery, a complete chemical plant—a satisfied customer.

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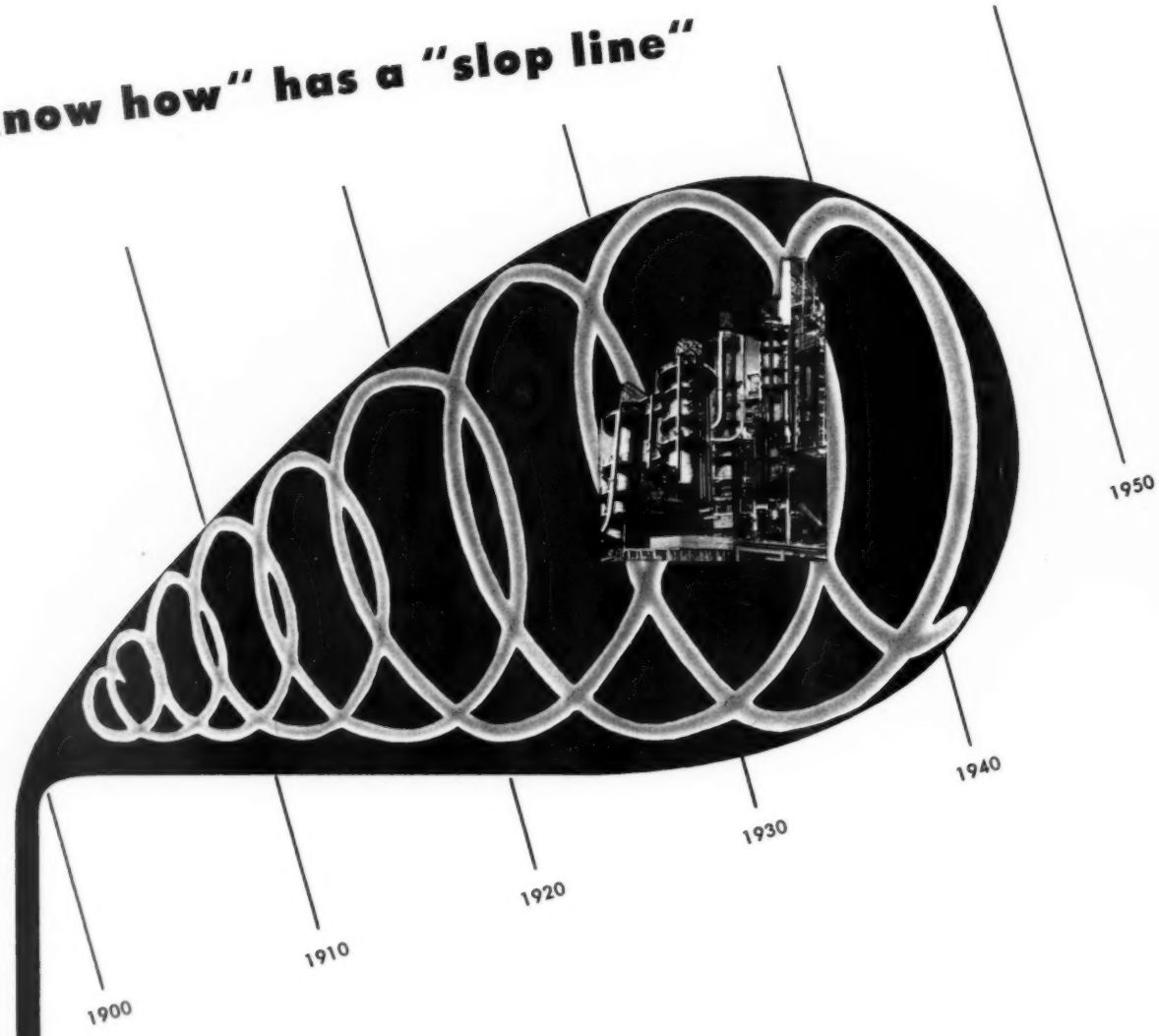
"know how" has a "slop line"



A live, active and serviceable "know how" is one which is continually undergoing revision in the light of current knowledge—the obsolete must be drawn off.

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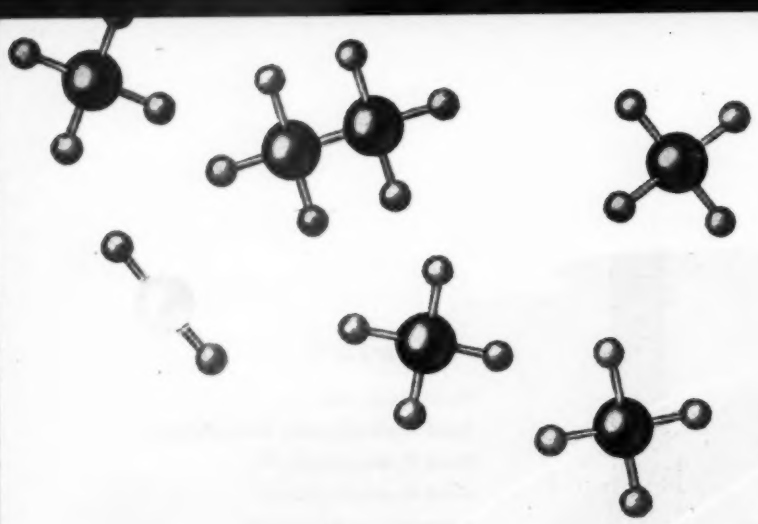

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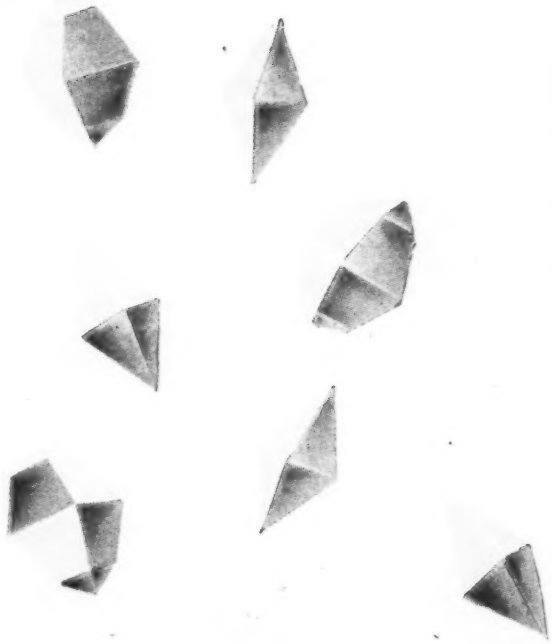

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Santa Fe freight, powered by 5400 HP Diesel-electric locomotive, in a mountain pass near San Bernardino, Cal.

Wide-Cut Diesel Fuel Proposed for Rail Use

PETROLEUM PROCESSING

FEBRUARY, 1949

THE use of "wide cut" Diesel fuels is proposed to railroad operators, in a paper by the Standard Oil Development Co., presented at the annual meeting of the Society of Automotive Engineers, Detroit, Jan. 10-14. The proposal is based both on laboratory work and on field tests conducted over many months in co-operation with an operating railroad.

The general adoption of the wide-cut fuel would have the effect of increasing the flexibility of refinery operations, and would permit the refiner to turn out unusually high yields of Diesel fuel when required. For refineries having an assortment of crudes permitting blending to cetane and sulfur limits, the relaxation in specification limits would not have to be so great to accomplish the desired increase in supplies.

The chief change required from present specifications would be lowering the flash point from the present generally accepted 150° F. to 130° F. Laboratory and field test work indicates that performance would not be impaired by thus expanding the range of stocks from which the refiner can supply railroad Diesel fuels. The 130° F. flash is also considered entirely safe for railroad service.

Consumption rate by Diesel locomotives averaged about 80,000 b/d in 1948, having increased more rapidly in the past 10 years than for any other petroleum product. More than 25% of the entire Diesel fuel demand now stems from the Diesel locomotive and this percentage is expected to increase. Table 1 compares the 10-year increase in demand for Diesel fuel in the U. S. with that for other products.

It is now estimated that the railroad Diesel engine production rate in the U. S. will probably exceed 3,000,000 rated-horsepower per year over the next 5 years. This will result in an increase in the demand for railroad Diesel fuels of about 20,000 to 25,000 b/d every year during this period.

"Therefore", the paper states "it seems reasonable to estimate that by 1953 the railroads in this country will be using about 200,000 b/d of Diesel fuel. It is also estimated that, on the basis of 1945 and 1947 figures for haulage, if all railroad duties were taken over by Diesels, the total consumption of Diesel fuel would be in the neighborhood of 300,000 b/d".

On the basis of these calculations, it is brought out, the present 270,000 b/d of fuel oil consumed in oil-fired steam locomotives about equals the volume of Diesel fuel required to power all the railroads if completely converted to Diesel.

A recent compilation of users' specifications for railroad Diesel fuels shows the following points:

1—Flash point appears to be limited at 150° F. and probably 120° F. would be satisfactory. Such a flash point is characteristic of kerosine, and kerosine or blends thereof have been used satisfactorily in bus and truck Diesels.

2—Cetane number requirements seem to average about 45, though some purchasers require 50. It is felt that this requirement is not necessary to satisfactory performance of the engines for which the fuels are specified.

3—Sulfur content varies from 0.5% to 2.0%. It is felt the lower limit may not be needed when specified.

TABLE 1—Rate of Increase in Demand for Diesel Fuel and Other Products

(Thousands Bbls. Daily)

Product	1938	1947	10-Year Increase	% 10-Year Increase
Gasoline	1433	2178	745	52%
Kerosene	154	281	127	82%
Diesel	58	200	142	245%
Other Dist.	264	617	353	133%
Residual	800	1420	620	77%
Other	406	753	347	85%
Total	3115	5449	2334	75%

An illustration is given of what one refiner could do to extend supplies of railroad Diesel fuels from his pool of crude oil stocks with some easing of the above specifications, and is further shown in Fig. 1. Starting with a specification base of 50 minimum cetane, 0.5% maximum sulfur and 150° F. minimum flash, the following could be done at the expense of other products:

1—45% increase of 50 cetane number provided the flash could go to 120° F. and sulfur to 1.0%.

2—80% increase of 150° F. flash and 0.5% sulfur if the cetane number could be dropped to 35.

3—130% increase of 150° F. flash if the sulfur could go to 1.0% and the cetane number to 35.

4—220% increase if the flash could go to 120° F. the sulfur to 1.0% and the cetane number to 35.

"It will be noted", states the paper, "that the above series involves a group of 130° F. flash fuels since by this route, called 'wide-cutting', it is possible to extend supplies with the least degradation in cetane number and sulfur content. The advantages of this method are based on the interdependence of supplies of kerosine and high quality Diesel fuels. Both generally come from the same type of crude but maximum yields of both cannot be produced by the refiner from the same center fraction. When producing Diesel fuel there are also produced light kerosine fractions not marketable as such and when producing kerosine there are heavy Diesel fuel fractions which also present a problem.

"This fact is graphically illustrated in Fig. 2, which shows a schematic volatility comparison of a typical kerosine, a conventional Diesel fuel and a wide-cut Diesel fuel. In effect, the kerosine is the coat and vest, the present Diesel fuel the vest and pants. The wide-cut 130° F. flash fuel is the coat, vest and pants and results in larger coverage for Diesel fuel supplies, by utilizing the light and heavy fractions which are not readily usable in conventional fuels.

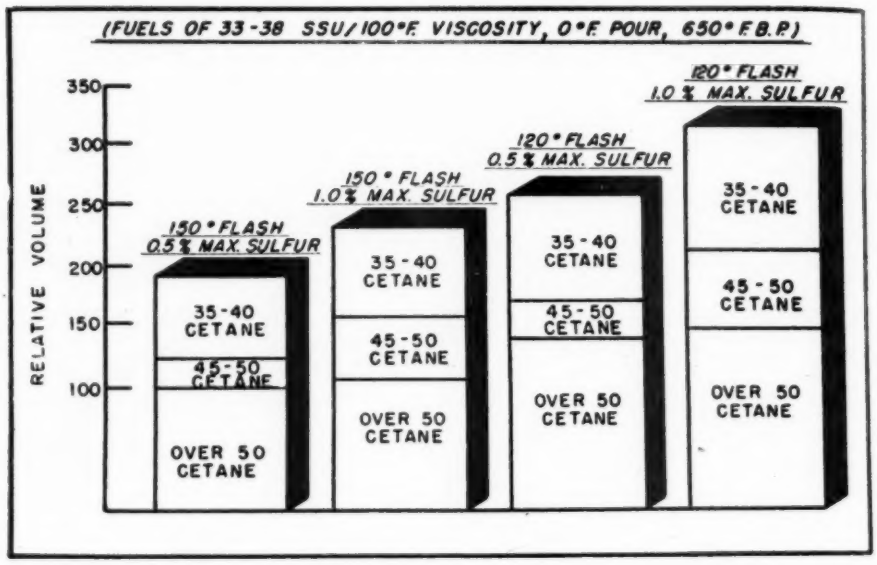


Fig. 1—Relative volumes of Diesel fuel content of crude possible with changes in flash point, cetane number and sulfur limit specifications

TABLE 2 — Specifications for Diesel Fuels Used in Field Tests and for Conventional Fuels

Inspection	Conventional Fuel	Wide-Cut Fuel High C.N., Low S.
Viscosity @ 100° F., SSU.	35	33
Pensky-Martens Flash Point, °F.	150	130
Cetane No.	50	50
Sulfur, Wt. %	<0.5	<0.5
Distillation, °F.		
Initial Point	350	310
50% Point	510	490
90% Point	585	600
End Point	650	650
Heating Value		
Low, BTU/Gallon	128,800	127,500

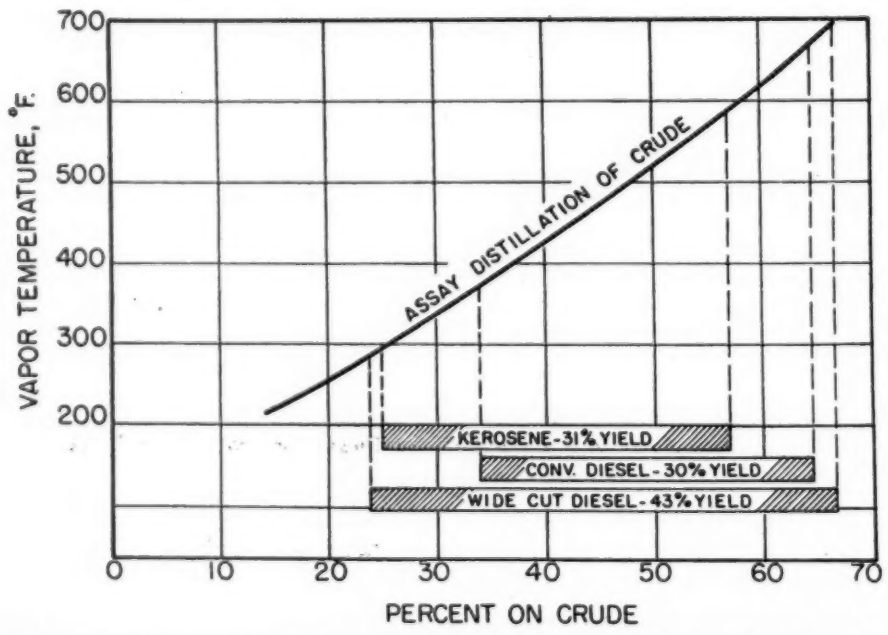


Fig. 2—Production of kerosine or Diesel fuel showing effect of wide-cutting the Diesel fuel yield

"Its adoption would have the effect of increasing the flexibility of refinery operations, and would permit unusually high yields of Diesel fuel when required. An equivalent increase does not result from mixing kerosine and Diesel fuel in the field —the operation must be carried out in the refinery during the actual distillation process."

While laboratory work by Standard Oil Development Co. had shown that certain variations in Diesel fuel characteristics were practical, it was felt that field data on full-scale equipment under representative operating conditions were required. Accordingly in 1945 arrangements were made with the New York, Ontario and Western Railway and the Electro-Motive Division of General Motors whereby three locomotives have been entirely fueled for 15 months on the wide-cut fuels. Table 2 gives the specifications for Diesel fuels used in the test and for conventional fuel.

Test locomotives were 2700 hp., Electro-Motive F.T. Diesels composed of two, 2-cycle, 16-cylinder (8½-in. bore by 10-in. stroke) engines. The locomotives were used in regular freight service and averaged one round trip per day of 240 miles with loads varying from 1000 to 2000 tons.

Detailed data is presented in the paper to show the wide-cut fuel has proven to be the equivalent of the conventional fuel in all performance aspects.

With regard to the safety aspects of the wide-cut fuel with its lowered flash point, it is pointed out that, in the automotive field, the use of kerosine-type fuels with flash points of 120° F. or lower has established this flash point level as entirely safe. A survey has also indicated that federal and state statutes would not prohibit the use of a 130° F. flash point fuel, as called for in the wide-cut Diesel fuel.

Preprints Available

The above article is a review of the following paper presented at the SAE Annual Meeting, Detroit, Jan. 10-14: "Wide Cut Diesel Fuels", by A. B. Crampton, S. H. Hulse and N. H. Rickles, Standard Oil Development Co. Readers may secure preprints of the paper by writing Special Publications Dept. Society of Automotive Engineers, 29 West 39th St., New York 18, N. Y.

Non-Flammable Hydraulic Fluids Developed for Aircraft Use

TWO NON-FLAMMABLE HYDRAULIC FLUIDS for aircraft have been developed, one by an oil company, it was brought out at the annual SAE meeting in Detroit. They were designed for the purpose of reducing the hazard of aircraft fires.

The fluids, to the extent of several million gallons annually, are used in the hydraulic systems of aircraft for operating brakes and other controls; and in some instances the systems reach practically all parts of the plane. Up to the present the fluids have been petroleum base materials which, at the viscosity range of aircraft hydraulic fluids, have lower spontaneous ignition temperatures than gasoline. In modern aircraft, where the hydraulic systems employ pressures as high as 3000 psi., hydraulic fluid leakage may result in damaging fires as well as providing the immediate source of ignition for fuel or other flammable materials of the plane.

The expanded operation of commercial aircraft in the postwar period directed attention to the relatively greater importance of the fire hazard inherent in the petroleum type fluids and intensive research was started by some of the oil companies and aircraft manufacturers. California Research Corp. (Standard Oil Co. of California) has brought out a completely non-flammable fluid which has been released for commercial use. Properties of this product, identified as Fluid A, are given in Table 1.

Of even possible wider significance, this paper stated: "This type of fluid also offers interesting possibilities as a lubricant for aircraft jet and turbo jet engines, where similar problems of low temperature operation, highly loaded gears and potential fire hazards are found. Its use is also being considered for special uses in the industrial hydraulic field such as high temperature die casting, where the proximity of molten metal creates an extreme fire hazard."

The composition of Fluid A is described as follows: "The principal ingredient of the new product is a halogenated non-aromatic hydrocarbon. The halogenated ingredient is inherently stable as compared to other non-aromatic halogenated hydrocarbons having properties suitable for use in hydraulic fluids. However, our early work showed that even this material developed acidity at elevated temperatures. Considerable research and experimentation was required to eliminate this corrosive tendency.

"Perhaps the most significant achievement of the experimental work was the formulation of an inhibited fluid which is non-corrosive to aircraft metals even under greatly accelerated conditions of high temperature and prolonged use in 3000 psi. systems. Fluid A also contains other additive materials necessary to depress the freezing point, reduce wear, increase the viscosity index and decrease foaming. It does not develop tackiness in exposed thin films."

The halogenated fluids are said to be fire extinguishers rather than fire promoters and to offer low temperature viscosities comparable to the present petroleum-base fluids meeting the specifications of the armed services. One difficulty is said to be the seal problem, a special type of rubber being required where these fluids are used. Such rubber packings are said to be now available with swell values in the order of 20% which is generally considered satisfactory. These materials have given good results in pump tests with Fluid A. It is expected that, with the commercial availability of non-flammable fluids, the development of even more suitable packing materials will be accelerated. An extensive research program in this same field started by the Douglas Aircraft Co. in 1946 has resulted in the development of an ester-base non-flammable hydraulic fluid. This product, known as DMX-8 through the experimental stages and now known as Skydrol, has been assigned to the Monsanto Chemical Co., who will manufacture and market the material. Its viscosity-temperature characteristics are shown in Table II, as compared with those of Specification AC 3580 for petroleum-base fluids used by the commercial airlines. DMX-8 is composed almost entirely of high-boiling, low-volatility esters of equal fire resistance. Regarding the product it is stated:

"An ester-base fluid such as DMX-8 offers significant and real improvement in hydraulic fluid fire resistance, pump life and reliability and fluid stability. Its use will impose no reduction in viscosity performance in aircraft which will operate satisfactorily on AC-3580 type petroleum fluids. Some design changes or low temperature performance limitations will be imposed on aircraft requiring an AN-0-366 (military) type fluid.

"Experience indicates that continued intensive development will result in an improvement in the viscosity and fire resistance of DMX-8 to a point acceptable to the armed services".

Problems are recognized in connection with rubber packing and elastomeric and plastic insulating, gasketing and sealing materials requiring resistance to hydraulic fluids,

TABLE 1—Properties of Non-Flammable Hydraulic Fluid A

Density at 60° F., gms/cc	1.510
Viscosity, Centistokes	
210° F.	2.95
130° F.	5.88
100° F.	8.54
—40° F.	425
Pour Point, °F	—95
Low Temperature Storage (72 hrs. at —65° F.)	Remains Fluid
Acid Number	Nil
Miscibility with Petroleum Base Fluids	Complete
Oxidation and Corrosion Tests (Spec. AN-0-366; 168 hrs. at 250° F.)	
Corrosion of Metals	Nil
Acid Number after Test	Nil

TABLE 2—Comparable Physical Properties of Typical AC 3580 Type Petroleum-Base Hydraulic Fluid and DMX-8 Fire Resistant Fluid

Property	AC-3580	DMX-8
Sp. gravity at 60/60° F.	.859	1.079
Pour Point, °F.	—55	Below —60
Viscosity, Centistokes		
@ 210° F.	4.37	3.85
@ 100° F.	19.3	15.0
@ —30° F.	3000	2256
Viscosity Index, ASTM	155	160
Autogenous Ignition Temp. °F. (ASTM)	495	1050

or which the fluid may contact. Along this line the report states:

"The use of any proposed hydraulic fluid with chemical solvent properties greater than presently-used petroleum fluids requires extensive consideration of all of the materials used in airframe construction and airframe accessory equipment."

In an evaluation of hydraulic fluids presented in a paper by Fred O. Hosterman, Lockheed Aircraft Corp., it was brought out that the relative weights of the various fluids constitute an economic problem for the airline, inasmuch as they would materially affect their payloads over a year's operations.

The hydraulic fluid article is a review of the following papers presented at the SAE Annual Meeting, Detroit, Jan. 10-14:

"A Completely Non-Flammable Aircraft Hydraulic Fluid" by B. B. Farrington, N. W. Furby and J. M. Stokely, California Research Corp.

"Development and Testing of Fire Resistant Hydraulic Fluid", by D. H. Moreton, Project Coordinator, Douglas Aircraft, Inc.

"Evaluation of Non-Flammable Hydraulic Fluids", by Fred O. Hosterman, Hydraulics Design Specialist, Lockheed Aircraft Corp.

Preprints Available

Preprints of these papers may be secured by writing Special Publications Dept., Soc. Automotive Engineers, 29 W. 39 Street, New York 1, N. Y.

Make Better Use of Octane Values in Present Fuels, Car Makers Urged

WHILE THE MOVE TO IMPROVE engine efficiency by raising compression ratios is under way, increasing study is being directed to means for making better use of the octane values of present fuels, and for the general improvement of the efficiency of automotive vehicles to reduce gasoline consumption, it was brought out at the annual SAE meeting in Detroit.

The possibilities for making better use of the octane values of present fuels were discussed by R. J. S. Pigott, chief engineer, Gulf Research & Development Co., together with the long range improvement in engine efficiency possible through going to higher compression ratios.

The current year, he said, will probably see engines of somewhat higher compression ratios. These engines, more carefully designed for better cooling than has been usual, will run on the present 85 to 92 Research octane premium fuels. He also referred to better cooling as one means for keeping down octane demand by securing more efficient use of the octane values of present fuels.

"For keeping down octane demand," stated Mr. Pigott, "a better job of jacket cooling, especially in controlled flow around exhaust valves, better cooled exhaust valves, probably sodium filled; cooler intake—all these are desirable and perfectly attainable."

The obvious move for improvement in engine efficiency is to improve the cycle on which it operates, that is, raise compression (and expansion) ratio. For example, the saving by the ideal cycle for 7.75 compression ratio is approximately 9% over 6.5 C.R., but the actual saving in the vehicle as operated is much higher, twice as much, he stated, the reason being that subsidiary savings are accomplished.

"The rise in compression ratio increases indicated mean effective pressure, but the breathing and other engine losses do not materially increase, so that engine mechanical efficiency increases quite noticeably. In addition, if designed for the same brake horsepower, the engine is smaller and so are these engine losses. Further, the reduction of exhaust dilution by higher compression ratio improves part-throttle efficiency.

"The purpose is, if possible, to move up to 12.5 compression ratio as fuel becomes available. Experimental engines so far built need about 100 octane Research at 12.5 C. R., not available yet, and not likely to be in large volume. The operating gain for this ratio is 35 to 40% over 6.5 C.R., worth trying for".

However, increased octane value is only required if we increase compression ratio in a single stage, as in our present engines, and do nothing else, said Mr. Pigott speaking along general lines. "There are several ways in which the need for higher octane gasoline can be avoided. One is to employ the dual fuel idea offered in several forms. One form, the use of alcohol and water, is presently preparing for full-scale commercial trial, chiefly for trucks. Compression ratios of 8:1 or higher can readily be handled for this supplementary fuel, using 4 or 5% for peak octane demand, that is, near or at full throttle.

"Another path is to extend the turbo-supercharged idea. If more power only were needed, supercharging as at present will get that easily; the real compression ratio is the product of the supercharge ratio times the cylinder compression ratio and, unless something else is done, would require about the same octane value as the cylinder compression ratio alone at 12.5 C.R.

"But since the compression is two-stage, with a supercharge it is possible to apply an aftercooler between the supercharger and engine, greatly reducing the octane demand of the engine by cooling the charge. We have proof this is so. A racing engine built 10 years ago was supercharged to 2.25 C.R. (17 psi. gage), cylinder ratio 6, overall compression ratio therefore 13.5. The aftercooler dropped the temperature at the engine inlet 60 degrees and the unit ran on an 82 ASTM gasoline (of low sensitivity) without detonation.

"To get economy it would be necessary to increase expansion ratio equally, possibly by extending the turbo-supercharger idea and putting on a gas wheel big enough to use all the exhaust gas energy, which is more than that required to drive the blower. The set must then be geared to the engine. If we increase supercharge to something like 25 psi. gage, we can use up all the engine exhaust energy for the blower and the turbo-supercharger need not be geared to the engine. But such a move will require a considerable redesign of the engine, since average and heat temperatures rise considerably. The piston would undoubtedly require liquid cooling and better jacketing and possibly improved valves are indicated. In effect, this is two-staging the expansion which is needed to get the economy; in supercharging only the compression ratio is raised but the expansion ratio remains that of the cylinder only, so there is no gain in economy."

The best of the present engines for road vehicles does not exceed 0.55 bhp. per cubic-inch, said Mr. Pigott, unsupercharged aviation engines 0.70, supercharged aviation engines a little over 1.0; the racing engine mentioned above 1.5. "This shows what is in the wood if we want to get it, he said." Obviously, reduction of weight per horsepower, which accompanies increase of horsepower per cubic inch (or BMEP, same thing, nearly) is valuable in permitting a reduction of weight in the whole chassis carrying the engine. There are more miles per gallon in lugging 2500 pounds dead weight around than 3000.

It is also quite possible, said Mr. Pigott, that quite a good deal could be done in the future to improve the general efficiency of the automotive vehicle. In spite of the relatively high full-load efficiency of the inter-

nal combustion engine, actually, as operated on the road, the load is for a very large percent of the time much less than maximum power, and the efficiency is consequently very much worse. Heavy-duty vehicles like buses and trucks operate at much better condition, better load factor and work at better average efficiency than the passenger car.

"Improvement of part-throttle efficiency would improve this situation", he stated. "Reduction of losses between engine clutch shaft and tire surface on the road would be very advantageous. For example, a complete variable speed transmission of high efficiency which kept the engine speed down toward 1500-1800 rpm. most of the time, and with the throttle wide open, might save as much as 25% in gasoline consumption without any changes in present engines".

The lubricating oils now available will perform satisfactorily in the higher compression engines of the future, in Mr. Pigott's opinion. "The present Diesel engines are running at compression ratios of 13.0 and higher", he said. "The ring belt conditions are a trifle more severe than most of the heavy-duty gasoline engines, but we are lubricating both quite satisfactorily now. Diesel engine bearings are giving, if anything, less trouble than heavy-duty spark ignition engines. It is thought that this is mainly due to the more general use of oil coolers and of more generous design".

For safer lubrication of engines of the future he suggested oil-cooled pistons and a calculated lubricating system flow; more rigid bearings to avoid misalignment and roughness. These will give the rings and bearings a calculated life expectancy.

The effect of many variable factors on the octane number requirements of automotive engines in service is being studied at length by the Ethyl Corp., and data on some of the work was reported to the SAE. These included atmospheric variables such as barometric pressure, temperature and humidity. Combustion deposits, types of fuels and lubricants, ignition timing, hot-spot temperatures and cooling jacket temperatures were also among subjects examined for their effect on the octane number requirements in engines in service.

Tests showed that deposits in the combustion chamber can make material difference in octane requirements of the engine. Tests on 162 cars before and after removal of deposits showed an average decrease in octane requirement after removal of 9.4 octane numbers. The tests showed no difference in effect of deposits from clear and leaded gasolines. Naphthenic lubricating oils were found superior to paraffinic oils in holding down an increase in octane number requirements.

TABLE 1—Summary of Estimates of Increased Miles Per Gallon by Various Means (From W. S. James' paper)

Item		Range	Approx. Avg.
Reduction of Heat Loss and Incomplete Combustion		10% to 40%	15%
More Accurate Carburetor Metering		5% to 50%	15%
Fewer Traffic Stops		10% to 25%	20%
	Design Modifications		
	Ideal Road Load	**Max. Wide Open Throttle**	**Present Road Load**	**Possible Wide Open Throttle**
Overdrive	+20%	+37%–0%	+13%	+26%–0%
Lower Wind Resistance	+ 9%	0%	+ 8%	0%
Weight Reduction (15%)				
Smaller Engine	+17%	+15%	+16%	+16%
Axle Ratio Change	+12%	+13%	+10%	+12%
12-1 Compression Ratio				
Smaller Engine	+33%	+22%	+30%	+17%
Axle Ratio Change	+40%	+24%	+36%	+18%
Supercharging				
Smaller Engine	+17%	0%	+17%	0%
Axle Ratio Change	+24%	— 5%	+17%	—12%
Automatic Transmission	+48%	0%	+37%	0%
	Estimated			
Smaller Engine				
10 to 1 Compression Ratio	+25%	+16%	+22%	+12%
8 to 1 Compression Ratio	+12%	+ 8%	+11%	+ 6%

Practically everything with which an engine comes in contact has an effect upon its octane requirement, the paper concluded. It is highly unlikely that the utopia of all engines having the same requirement will ever arrive. "Study of the effects of various types of fuels and lubricants offers interesting possibilities for reduction of requirements due to deposition."

The fact that the cost of gasoline is now about one-third of the cost of operating a car indicates the importance of increasing the miles per gallon achieved in driving, and led to a report before the SAE by W. S. James, Fram Corp., outlining some of the phases of the problem of obtaining more miles per gallon. The paper also estimates the possible gains to be made in following some of the more generally recognized means available for increasing gasoline mileage.

This was done by using as a basis for comparison an estimate of the resistance to be overcome in rotating the engine and in propelling the vehicle, and this resistance used to determine the possible miles per gallon with (1) ideal thermal efficiency and (2) with thermal efficiencies reduced by normal losses from incomplete combustion, radiation and so on. These two values of miles per gallon were taken as giving a reasonable basis for judging the potential fuel saving by the method under consideration. A mathematical procedure was set up for estimating the work done by the fuel. The results in percentage savings in gasoline are given in Table 1.

"An examination of the results will show that there is more than one method by which miles per gallon can be increased by significant amounts" it is concluded. "Which of these methods, or others, are used to increase miles per gallon will depend on many factors—the specific car or engine under consideration, manufacturing costs, tooling charges, operational simplicty, fuel availability, etc.

"The engineers of the automotive industry are familiar with all these paths to greater miles per gallon and, when the overall compromises indicate the desirability of their use, they will be adopted and the motoring public will get more and more miles for its motoring dollar."

In considering the effect of various types of automatic transmissions and fluid drives on the fuel antiknock requirements of engines, the torque converter was chosen for study in preference to other types of drives, since it seemed likely to impose the most drastic change in engine operating condition.

The test work by Ethyl Corp. indicated that, while the torque converter changed the knocking pattern of the engines from knocking at low speed to knocking at high speed, a typical commercial fuel that satisfies the engine requirement at low speed with a standard transmission will also satisfy its requirement when a torque converter is used.

The accompanying article is a review of the following three papers presented at the SAE Annual Meeting, Detroit, Jan. 10-14:

"Alternate Fuel or Power Sources in Event of Continuing Petroleum Scarcity and Cost Increases", by R. J. S. Pigott, Chief Engineer, Gulf Research & Development Co.

"Factors Affecting Octane Number Requirement", by Harold J. Gibson, Research Coordinator, Ethyl Corp.

"Some Factors in Gasoline Economy", by W. S. James, Vice President of Engineering, Fram Corp.

Readers may secure preprints of the complete papers by writing Special Publications Dept., Society of Automotive Engineers, 29 West 39th St., New York 18, N. Y.

Midget Gas Turbine a Possibility For Ground Vehicles, SAE Told

A MIDGET, TWO-STAGE, GAS TURBINE ENGINE, weighing 150 pounds without accessories and developing 200 horsepower, was introduced at the SAE meeting in Detroit by the Boeing Airplane Co. as the possible forerunner of a type of jet-propelled power plant applicable for ground and water vehicles as well as small aircraft.

This was in a paper entitled, "The Boeing 200 H.P. Gas Turbine", by S. D. Hage, Propulsion Development Unit Chief, Boeing Airplane Co., Seattle.

Its rated specific fuel consumption will vary between 1.5 and 1.0 lb./BHP-hr., based on laboratory experience with the present model. Fuel used so far has been mostly kerosene, with some Diesel fuel and some 60-octane gasoline. It was stated the kind of fuel is not important so far as combustion is concerned as long as it will mix with air. The type of fuel used, however, does affect the rate of carbon deposition in the burner liner.

Boeing's interest in gas turbines dates from 1943, when the company was asked by the Air Forces to work on an engine for a high speed turbojet medium bomber. The company continued its study when the wartime incentive was removed, keeping the work to relatively small scale to hold the cost to a minimum. Hence the midget gas turbine, now felt to be successfully through the development stage, but not as yet actually installed in a vehicle of any sort.

The engine consists of a single-stage centrifugal compressor with two outlets, two constant pressure burners and a compressor driving turbine. This primary stage, or hot gas producer, has a rated speed of 36,000 RPM and drives the accessories. The secondary or power output stage consists of another turbine with a rated speed of 24,000 RPM and a 9.6:1 reduction gear, giving a rated output speed of 2500 RPM. The speed of the primary stage is entirely regulated by the fuel flow. The speed of the secondary stage is independently regulated by the load and it can be varied from stall to runaway or maximum safe speed.

The weight of the engine without accessories is approximately 150 lbs. The power output will vary between 100 and 200 PHP, depending on the endurance life expected. The engine is extremely easy and consistent to start; it can develop rated power 15 seconds after the start is initiated. It can accelerate rapidly, going from idle, which is about 10,000 RPM, to full speed in 5 seconds. It is described as practically vibrationless if the rotating parts are accurately balanced; destructively rough if they are not. Basic simplicity of the gas turbine is illustrated in Table 1, which compares the number of parts and the number of running machined fits with other reciprocating-type engines.

Fig. 1 illustrates some of the important performance characteristics of the Boeing midget gas turbine and their comparison with other engines. Two types of loads are shown by the dotted lines; a grade load representing one extreme in load type and an air friction load the other extreme. The BHP curve for the gas turbine provides considerably more excess power for acceleration than the reciprocating engine for either type of load. In addition the gas turbine cannot be stalled, which is also shown by the torque curves. The reciprocating torque curve falls to zero at zero speed; the gas turbine stalled torque is twice the rated speed torque.

The solid SFC curves are for an air friction or cubic load. It is considered that the best economy point for any power, in the case of the gas turbine, lies on a cubic load curve. Since such a load is characteristic of most power requirements in the transportation field — land, water and air—this type of engine is considered suited to a wide variety of uses without any complicating load varying devices. It is emphasized that a gas turbine without a free power turbine is not very suitable for general applications. The direct connected machine has a maximum power characteristic very close to the air friction load and will stall if loaded below about 40% speed.

Offsetting some of the desirable features of a small gas turbine are such factors as very high air consumption, and large intake and exhaust friction losses which as yet are not tolerable. A complete solution has not been found for the compressor inlet noise problem, which is especially difficult because of the large flow and the necessity for very low pressure drop. Idle fuel consumption is high, roughly one-fifth of full power consumption.

Production costs are unknown but it is estimated they will be less per horsepower for the turbine than reciprocating engines.

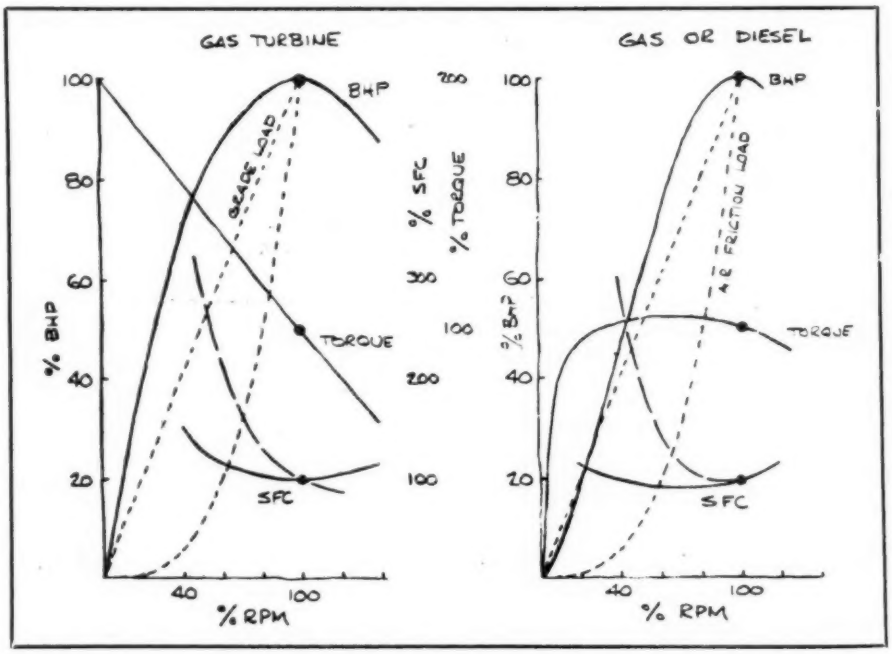


Fig. 1—Chart of performance characteristics of Boeing gas turbine and reciprocating type engines

TABLE 1—Number of Parts, Boeing Gas Turbine and Reciprocating Engines

	Boeing 502	Lycoming 0-435-2	Gray 64-HN-9	Waukesha 6WAK
Number of Parts in Engine	175	...	590	...
Part Numbers in Engine	220	...	1400	...
Complete Overhaul Parts List	20	160	210	150
Number of Close Tolerance Running Fits	16	100	135	100

NEW "CAT-CRACKER" DESIGN

A REPORT ON HOUDRIFLOW

Flue Gas Lift for Catalyst Makes Possible Higher Circulation Rates, Lowers Requirements for Feed Preheat and Cooling Coils in Kiln, thus Reducing Investment and Operating Costs

DESIGN features contributing to the low initial and operating costs for the new improved moving-bed catalytic cracking process known as Houdriflow have been revealed to some extent in information released recently by Houdry Process Corp., its developers and licensors.

Initial capital investment for Houdriflow is reported to be 80% that of a Thermofor catalytic cracking unit of the same capacity, and economies in direct operation for a 5000 b/d unit are estimated to be approximately $474 per stream day. These advantages are said to stem from four basic changes in TCC design incorporated in Houdriflow units.

1: A flue gas lift transports pelleted or bead catalyst from the bottom to the top of the unit, replacing the bucket-type elevator of the conventional TCC process. This removes the practical limitation on catalyst circulation rate imposed by mechanical elevators, making available a wide range of circulation rates.

2: Catalyst-to-oil ratios in the range of 4:1 to 8:1 are provided, whereas conventional TCC units operate with ratios in the range of 2:1 to 3:1 because of elevator capacity limitations. Such a range of catalyst-to-oil ratios permits operation with stocks from 0 to 100% vaporized, and a reduction in the amount of reactor feed preparation equipment because a major portion of the reaction heat is supplied by the catalyst entering the reactor.

3: A simplified regenerator is made possible by the higher catalyst circulation rates. Since a major portion of the regeneration heat is absorbed by the flowing catalyst, one or two burning zones are sufficient.

4: A superimposed, self-supporting, circular reactor and regenerator section makes it necessary to lift the catalyst only once to complete a cycle of flow through the system.

The principal flows through a Houdriflow unit are shown in the flow diagram, Fig. 1. Regenerated pelleted or bead catalyst in the upper lift hopper (A) flows by gravity through the reactor seal leg (B) into the catalyst distributor head of the reactor (C). From this point the catalyst enters the reaction zone via two paths: an annular orifice located in the center of the top seal plate permits approximately 80% of the catalyst to enter the reaction zone in the form of an annular curtain which surrounds the mixed-phase reactor charge injection nozzle; the balance of the catalyst flows through peripheral feed pipes.

Continuing to flow by gravity, the catalyst passes downward through the reaction zone, through vapor disengaging and steam purging sections in the bottom of the reactor, and then by way of seal leg (D) into the distributing head of the kiln, or regenerator (E). The spent catalyst then flows into the kiln proper through a distributor especially designed to insure uniform distribution.

Leaving the bottom of the kiln, the catalyst flows by gravity through seal leg (F) into the lower lift hopper (G), from which point it is transported by means of flue gas from the kiln through the lift pipe into the upper lift hopper.

The oil charging stock may be delivered to the reactor in the liquid phase, in a partially vaporized state, or in a completely vaporized state. The more general case of partially vaporized, or mixed-phase, feed is assumed for this description. In this instance, any feed stock suitable for catalytic processing is preheated by

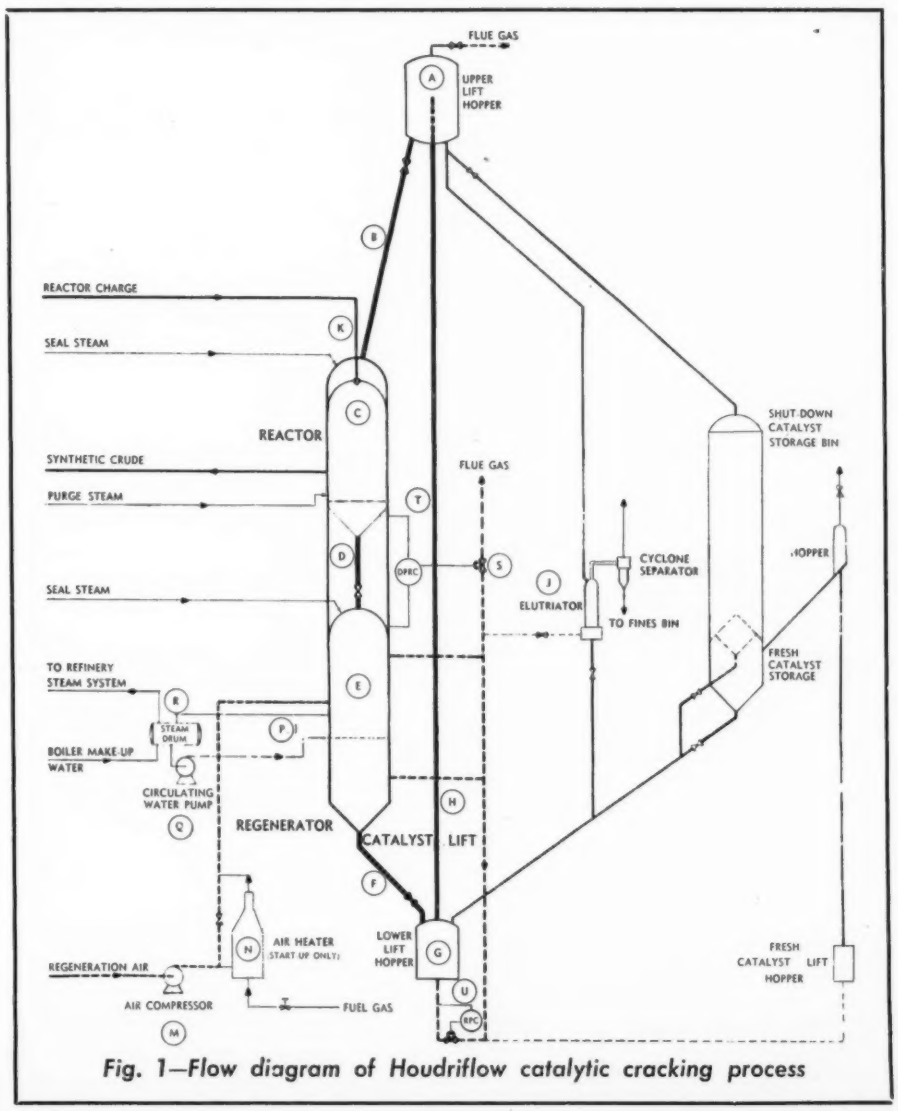
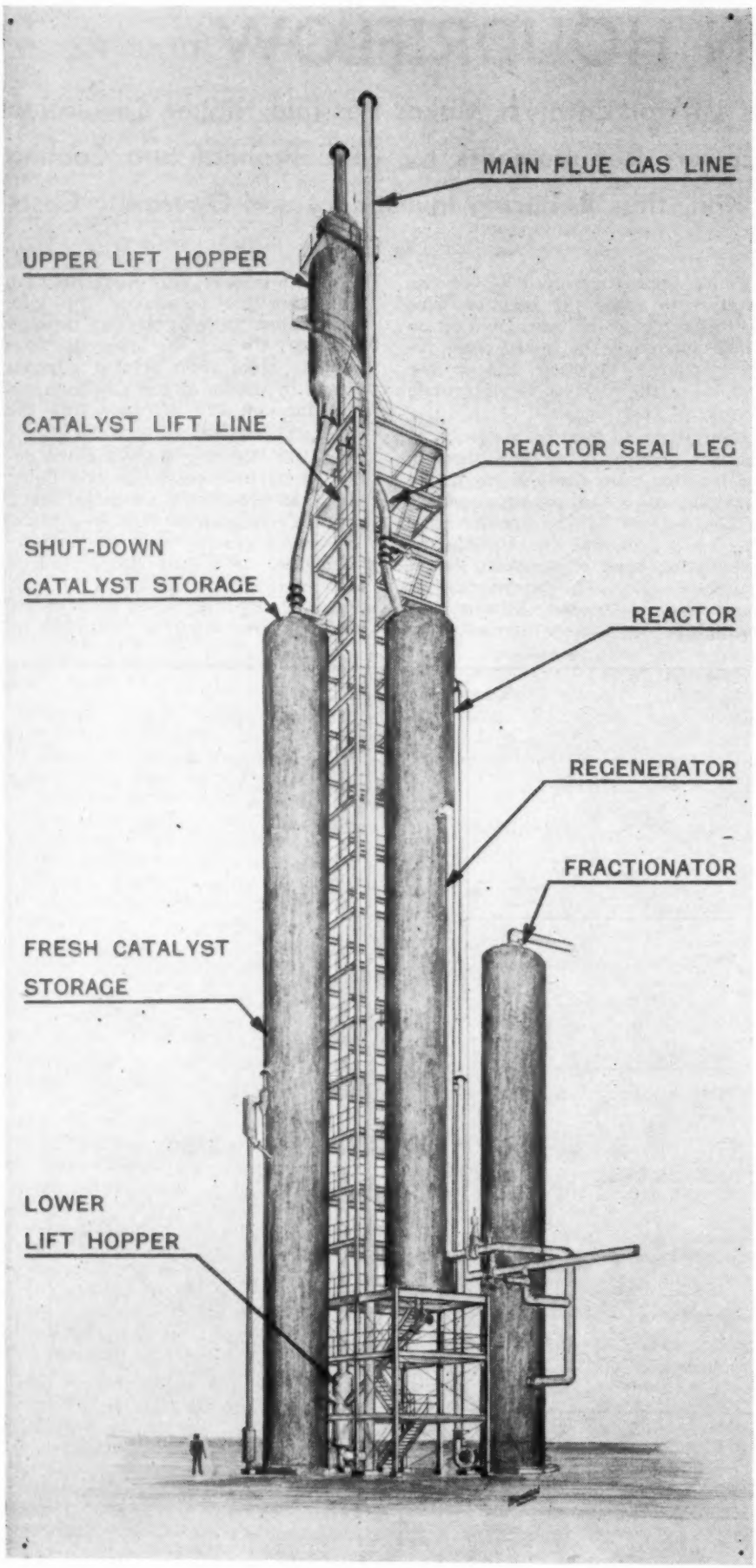


Fig. 1—Flow diagram of Houdriflow catalytic cracking process



Artist's perspective drawing of a typical Houdriflow unit

heat exchange and a fired preheater to a nominal preheat temperature of perhaps 700° F. The mixture then flows directly through the reactor charge line into an injection nozzle located centrally in the top of the reaction zone and inside the annular curtain of flowing catalyst described above. By means of the nozzle, the mixed-phase feed is atomized and directed onto the curtain of hot catalyst, which immediately completes the vaporization of the charge and brings the temperature of the vapor-catalyst mixture to the desired level.

The hydrocarbon vapors then pass downward concurrently with the catalyst through a solid-bed reaction zone. In the reaction zone a highly efficient contact between vapors and catalyst is achieved. Cracked vapors leave via a conventional TCC disengager device in the lower part of the reactor.

The spent catalyst flows from the disengager through a steam purging section before leaving the reactor. Countercurrent flow of steam to catalyst is said to strip the residual hydrocarbons completely, with even the heaviest reactor charges. There are no innovations from a conventional TCC design in the disengager or in the steam purge section.

Air for regenerating the spent catalyst, supplied by the blower (M) at about 10 psig., by-passes the air-heater (N), which is used for start-up only, and enters the kiln (E) through a channel-type distributor.

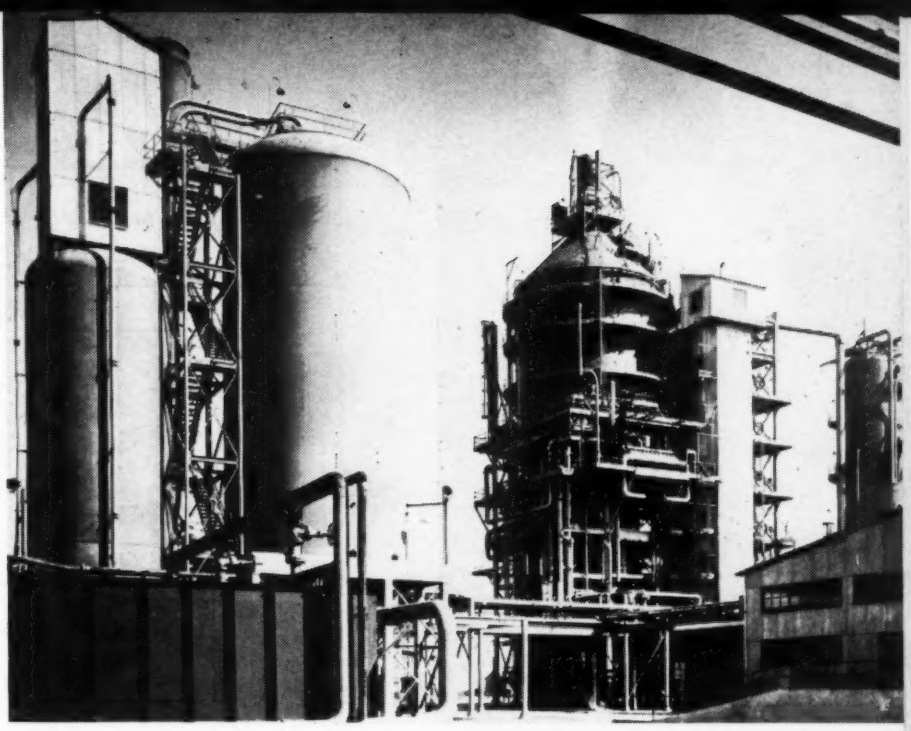
A bank of cooling coils (P) removes regeneration heat as required to maintain desired catalyst temperatures.

Pressure in the range of 5 to 9 psig. is maintained in the regenerator by means of the flue gas control valve (S), which is positioned by the differential pressure recorder controller (T).

Flue gas for the catalyst lift enters the lower lift hopper through pressure controller (U), engages and carries the catalyst up the lift pipe to the upper lift hopper (A), and from that point is vented to the atmosphere. No details as to the design of the catalyst lift mechanism are as yet available.

A working drawing for a typical Houdriflow unit of approximately 5000 b/d design capacity shows it will occupy a ground space measuring about 64 x 42 ft., including the fractionator as well as the main structure. Overall height of the entire unit is slightly over 200 ft. The reactor section is 14 ft. in diameter by about 40 ft. high; the regenerator is 18½ ft. in diameter by about 56 ft. high. Catalyst storage vessel is 12¾ ft. diameter by 130 ft. high, and has capacity for 300 tons of catalyst for shut-down purposes plus 50 tons fresh catalyst storage.

Data and illustrations in the accompanying article are from a study entitled "Design Progress and Economy in Welded Fluid Catalytic Cracking Plant", by Egon F. Brummerstedt, mechanical engineer, Petroleum Refinery Division, Foster Wheeler Corp., submitted to the James F. Lincoln Arc Welding Foundation, Cleveland, in its $200,000 Design-for-Progress Award Program for advances and improvements in the application of arc welding.



Photos courtesy Foster Wheeler Corp.

Fig. 1—Fluid catalytic cracking plant of Shell Oil Co., Inc. at Houston, where construction cost was reduced 10% by welded design improvements.

Welding Saves 20% in Steel In Cat-Cracker Equipment

Improvements were made, through use of electric welding, in the mechanical design of the large equipment of a modern Fluid Catalytic cracking plant. New techniques in welding facilitated the construction and assembly of the equipment. Comparisons in cost and weight with non-welded equipment are presented.

SAVINGS of 10% in the overall cost of a Fluid catalytic cracking plant built in 1946 at the Houston refinery of Shell Oil Co., Inc., were achieved through innovations and improvements in the design and construction of the largest pieces of equipment by electric welding.

The cracking unit, of a maximum charge capacity of 25,000 b/d, required 6,239,500 lbs of steel for the main equipment by welded design and construction. This was estimated to be 1,269,500 lbs. less than would have been required by non-welded design, a saving of 20% in steel for the main equipment. Actual cost of the main equipment was $2,042,770, while the cost by non-welded design was estimated to be $2,590,000. Cost savings in the main equipment thus were around 27%. Table 1 lists the weight and cost of the principal items of equipment going into the plant.

Total weight of equipment and materials used in the unit was a little over 5000 tons, not including common building materials such as concrete, brick or lumber used for temporary construction. The weight saving over non-welded design is estimated at 12%.

Field erection man-hours totaled approximately 750,000 for the complete plant, but only 50,000 man-hours were required in actual welding time in the field. For non-welded construction of a similar plant it is estimated that erection man-hours would have been 850,000, over 13% greater.

The item of engineering and drawings constitutes a considerable percentage of the total cost of a refinery unit or plant and, in this instance, material savings in engineering and drawing costs resulted from welded instead of riveted construction. Welded construction involves fewer small parts than riveted, is inherently simpler, and can be detailed using standard weld symbols as established by the American Welding Society, which are in general use.

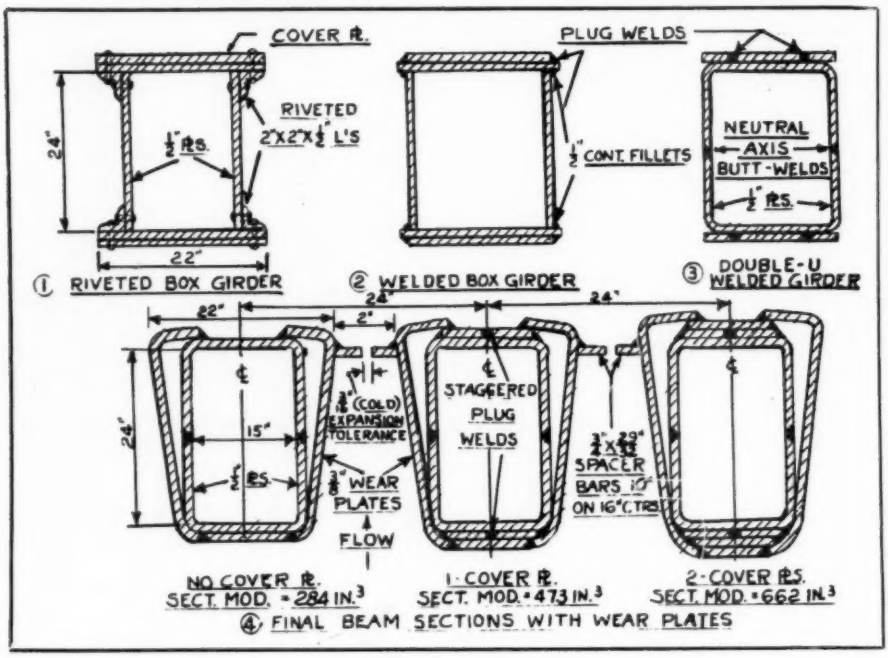
Another indirect saving, it is said, will be in the lower maintenance costs resulting from making necessary repairs during inspection turnarounds by the welded attachment of new metal parts to replace eroded surfaces. This point was kept in mind in the design of the plant.

The Fluid unit built at the Shell refinery has a charge capacity of 17,000 - 25,000 b/s/d. Catalyst inventory is 600 tons and the catalyst circulation rate is about 800 tons per hour. Utility requirements for operation under design conditions are given in Table 2. The plant was engineered and constructed by the Foster Wheeler Corp. Fig. 1 is a view of the completed unit.

Modifications of arc welding employed in its construction included automatic stud-welding, used in the regenerator liner attachment; resistance welding, in the fractionator alloy liner attachment and in the fabrication of the expansion joint bellows; and submerged melt welding in the fabrication of the catalyst coolers and piping. How electric welding was applied in the design and construction of the main equipment

Fig. 2 (left)—Fabricated regenerator grid beams

Fig. 3 (below)—Evolution of beam sections for regenerator grid



of the Fluid unit is described in the following:

Regenerator Shell

Carbon steel was used for the regenerator shell, with a 7-in. protective lining consisting of a refractory material and insulation, giving a 40-ft. inside diameter and 41-ft., 2-in. outside diameter.

Previous regenerators of this size had been made 1-in. thick in the straight shell and 1¼-in. thick in the conical heads, which would be adequate for riveted construction. The use of sharp corner welds at the junction of cylinder and cone which, because of the sudden discontinuity, resulted in high stress concentration, undoubtedly contributed toward these greater previous thicknesses.

Since the use of a knuckle radius or torus between cone and cylinder has been accepted as the best means for eliminating discontinuity stresses, toriconical heads with a knuckle radius of 5 ft. were specified for this vessel. Minimum required thicknesses were then calculated by fundamental formulae in the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and a 3/4-in. shell was decided on as satisfying the code requirement.

The top cone required a thickness of 7/8-in. due to the 45-degree angle of the cone with the vertical and the bottom cone was made 1-1/8-in. due to superimposed localized stresses resulting from grid beam supports and skirt attachment. The apex courses of the cones had lower stresses and their thickness was reduced to 3/4-in. These design changes reduced the total weight of the vessel approximately 25% from conventional design.

Among the access manholes and connections, of particular interest is a 78-in. diameter manhole for cyclone removal and general accessibility. This was attached to a plate of twice the normal shell thickness to provide integral reinforcement for replacement of the large hole cut in it. This heavy square plate was inserted in the bottom ring of the shell and the edges machined to suit the adjacent plate thickness. Comparable data on this shell and connections and shells of conventional welded and riveted design are given in Table 3.

TABLE 1—Tabulation of Weights and Costs for Main Welded Equipment

Item	Welded Design Weight 1000-lbs.	Welded Design Cost	Non-Welded Design Weight 1000-lbs.	Non-Welded Design Cost
1. a Regenerator Shell	420	$111,300	600	$155,500
b Regenerator Grid	140	29,200	150	41,000
c Regenerator Lining	440	60,300	460	73,500
d Regenerator Cyclones	70	94,000	85	120,000
2. a Reactor Shell	380	109,500	550	136,500
b Reactor Grid	47	7,120	50	10,500
c Reactor Cyclones	44	32,000	52	40,000
3. a Fractionating Tower	245	128,000	200	163,000
b Fractionating Trays & Pans	202.5	71,200	390	115,800
4. a Fresh Catalyst Storage Hopper	110	20,700	120	23,300
b Main Catalyst Storage Hopper	300	47,200	330	52,800
5. Catalyst Coolers (2)	320	105,000	380	140,000
6. a Catalyst Piping	185	125,000	215	150,000
b Expansion Joints	61	81,000	100	131,000
7. Slurry Storage Tank	27	4,600	30	5,300
8. Cooler Box & Coils	136	18,000	150	21,500
9. Small Tanks & Drums	195	46,000	220	55,000
10. Heat Exchangers	360	122,000	400	145,500
11. Piping (General)	1,930	692,000	2,300	845,000
12. Stack	77	9,600	95	12,000
13. Compressor House	250	32,500	300	40,000
14. Tubular Steam Generators	120	19,800	132	24,000
15. Steam Drums	126	38,750	140	45,000
16. Air Heater	20	14,000	22	17,000
17. Instrument Air Dryer	16	10,800	18	12,500
18. Inert Gas Generator	18	13,200	20	15,200
Totals	6,239.5	$2,042,770	7,509	$2,590,900
Estimated Savings	1,269,500 lbs. or 20.3% of actual weight and $548,130 or 26.8% of actual cost.			

Regenerator Grid

Design of the regenerator distribution grid was the most difficult design problem of the new Fluid unit. The conventional design used on other units had consisted of a sectional plate of meehanite castings perforat-

ed with several hundred 2-in. diameter holes. Low-chrome molybdenum alloy steels had been used to provide supports for the meehanite castings.

The assembly of the grid, particularly the supports, had represented a formidable problem because of operating conditions and the faults of this design had caused occasional shutdowns of the unit for repairs and replacement of grid castings and tile.

As a result of these disadvantages Shell Oil Co. engineers had specified a grid design for the new unit with the following characteristics:

1—Grid to have no intermediate supports in bottom cone.

2—No castings were to be used.

3—Grid to be capable of early assembly in the regenerator shell for use as a working platform for installation of cyclones and tile lining.

4—Replacement of sections due to erosion to be minimized.

An initial concept of a number of large parallel built-up beams was finally developed into the accepted grid design. The slots between the beams would serve as distribution openings for the catalyst and could be modified by spacer bars to give the desired area.

The decision to use beams to span the 40-ft. diameter regenerator brought up the problem of determining their shape, cross-section and spacing.

Process considerations called for narrow beams of minimum spacing, that is, on 12-in. to 18-in. centers. Structural considerations called for wider beams to allow proper anchorage and to resist lateral deflection of the compression section due to the long span. In order to minimize the latter, a double-web box girder was chosen, which is so stiff in torsion that lateral buckling failure of the compression flange need not be considered. Therefore, it was not necessary to make any reduction in the chosen allowable tensile stress of 7000 psi. for the 2¼% chrome, 1% molybdenum alloy steel used for the beams because of the slenderness or length-to-width ratio of the flange.

A maximum spacing of 24 ins. between center of beams was selected as satisfactory for catalyst distribution purposes and a similar maximum depth of beam was picked to keep pressure drop and dead space at a minimum.

The use of arc welding in the fabrication of the beams eliminated the need of structural angles at the corners, since a fillet weld could effectively join flange and web plate. An additional economy was provided by cutting the welds down to butt welds at the neutral axis and forming two plates into U-shapes. This also had the advantage of putting the weld at the point of minimum stress of the beam. The evolution of the beam sections is shown in Fig. 3. Fig. 2 shows the grid beam fabrication.

Process considerations required a total area of distribution openings between beams of approximately 4,000 sq. in. It was decided to make the open slot between beams equal to the diameter of the perforations on previous grid castings. With a maximum desirable length of 6 ins. per slot, 10-in. long spacer bars were required on 16-in. centers to leave the net area of openings at the desired figure. To protect the beams proper from catalyst erosion, carbon steel wear plates were welded to sides and bottom, as shown in Fig. 1, to form a streamlined Venturi-type restriction opening.

The ends of the grid beams were closed off with a combination seal and stiffener plate to prevent internal catalyst erosion. This required a means for relieving the pressure created by the air sealed off in the beam when heated to operating temperature of 1100° F. A filter of aloxite, a porous refractory of crystalline alumina, was inserted in a coupling welded to each end of the beam, which served to prevent passage of catalyst but allowed escape of excess hot air.

The problem of differential expansion between grid beams and insulated steel shell was solved by providing slotted bolt holes in the support brackets. A stainless steel bolt of 18% chromium and 8% nickel was used here, having at once high creep strength and a higher coefficient of expansion than the beam material.

In the fabrication procedure, bending the beam plates into the desired shape for the double U welded girders limited their thickness to 1/2-in., which was considered sufficient. For welding a high stainless alloy of 25% chromium and 20% nickel was used because of its inherent ductility and ability to reduce the air-hardening tendency of the low-chrome plate material by retaining its austenitic characteristics even after dilution with the lower alloy.

The total initial cost of the beam grid for the Fluid unit was approximately $29,200. For comparison, the previous grid design using meehanite castings supported on alloy pipe frames had a total initial cost of around $41,000.

Regenerator Lining

The heat-protective lining installed in the regenerator consists of two 2-in. layers of block insulation composed of an asbestos diatomaceous earth and 3-in. thick refractory tile suspended on heat-resistant meehanite castings forming continuous circular supports on 18-in. centers in the shell and 14-in. in the cones. The castings are bolted to steel tee clips welded to the shell on approximately 2-ft. centers. Fig. 4 shows the installation of the lining.

Among other features of the installation of the lining, a 1/2-in. carbon steel liner was installed covering the refractory tile at the apex of the bottom cone, where pressure fluctuations are most severe, extending up 7 ft. from the riser attachment. The plate liner was installed in trapezoidal sections, held in place by stud bolts welded to the cone. Around internal attachments and openings where the regular tile did not fit, special castable refractory material was poured and held in place by anchor studs previously welded to the shell.

Nearly 5000 of these studs had to be welded on and for this work a portable automatic welder was used for end-welding metal studs to metal surfaces. Normal operating speed of this machine is 100-200 studs welded per hour. It is estimated that approximately 10 studs per hour would have been welded by the old method.

Another innovation on this unit made possible by arc welding was the installation of catalyst shields at the

TABLE 2—Utility Requirements

Cooling water, gpm	11,100
Condensate and boiler feed water, lbs./hr.	168,320
Fuel gas, SCFH	256,300
Electric power KW	1,500
Excess 225-lb. saturated steam to gas plant, lbs./hr.	37,730
Excess 200 psig. superheated steam to refinery main, lbs./hr.	76,540

The last two items are the excess over plant requirements of the 215,000 lbs./hr. of steam generated at 225-lbs. pressure by the catalyst coolers and slurry steam generators. Of the above, 177,000 lbs./hr. is superheated to 200 psig. by the furnace which also preheats the charge oil.

TABLE 3—Cost Data on Regenerator Shell, Compared with Conventional Design

Design	Present ¾-in. Welded	Previous 1-in. Welded	Theoret. 1-in. Riveted
Approx. Weight, lbs.	420,000	550,000	600,000
Costs			
Shop Material	$58,300	$75,000	$83,000
Field Assembly Labor Cost*	42,400	52,800	58,000
Field Supervision, Tools, etc.	10,600	13,200	14,500
Total Cost	$111,300	$141,000	$155,500
*Man-Hours	25,000	31,000	34,000

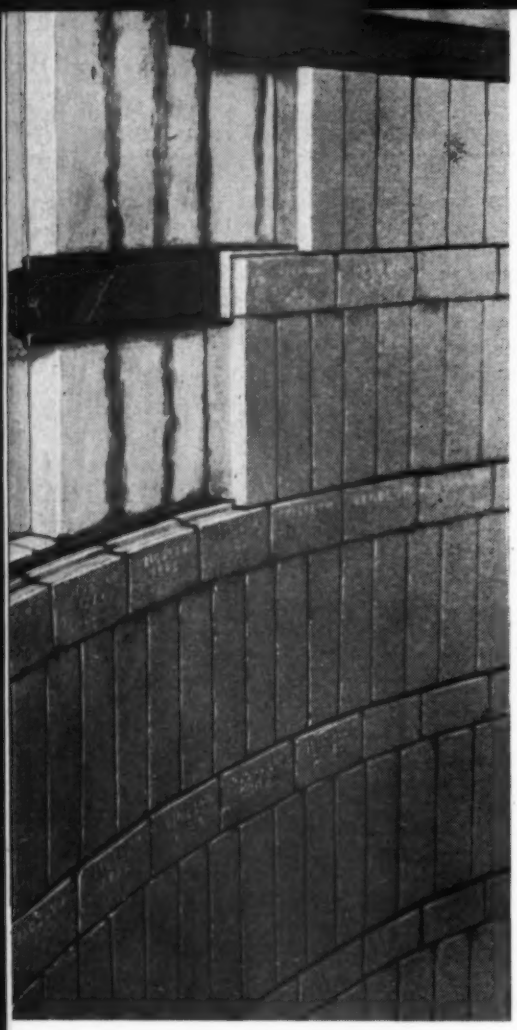


Fig. 4—Installation of heat-protective regenerator lining.

manholes. These consisted of ⅜-in. steel plates attached to the manhole lining sleeve flush with the inside tile by means of bolts threaded into nuts welded to the lining. The shields kept the manhole cylinders from plugging up with catalyst and also provided a continuation of the cylindrical surface at the openings. For the large 78-in. manhole, this shield took the form of a plug attached directly to the manhole cover and removed with it by means of a sliding trolley.

The cost of installation of the regenerator lining as welded was estimated at $60,300, while the cost of a hypothetical riveted construction was placed at $73,500.

Regenerator Cyclones

These consisted of two stages of 6 parallel cyclones each, arranged concentrically and supported on a frame suspended from the top cone of the regenerator. Fig. 5 shows the assembly of the cyclones. In preparing the mechanical specifications consideration had to be given to the possibility of after-burning caused by an excess of oxygen being introduced into the regenerator by the turboblower, with a resultant increase in the combustion temperature in the top or vapor phase section of the regenerator to as high as 1800° F. This had occurred periodically in previous units and attempts had been made to control it by the use of sprays.

This temporary high temperature called for the use of a higher alloy steel than had been specified for the grid. The selection was a straight chromium stainless steel alloy, containing 12% chromium with a little aluminum added (0.10-0.20%) to reduce air-hardening after welding. The welding electrode was 25-20 stainless steel. Carbon steel wear plates were inserted at the cyclone inlets to resist anticipated erosion. The support frame was specified as stabilized austenitic stainless steel, since only a material with a very high creep and short-time tensile strength could be used here for the possible 1800° F. temperature. The frame was suspended by six 2¼-in. diameter hanger rods attached to support clips welded to the top cone. While these rods preferably would be made of the same material as the frame, the higher expansion coefficient of that metal necessitated the use of the same 12% chrome alloy used for the cyclones to prevent differential expansion.

The total weight of the cyclone bodies and support frame by welded design was 70,000 lbs. and the cost, including engineering and royalties, was $94,000. The estimated weight by a design not including welding is given as 85,000 lbs. and the cost $120,000.

Reactor

Because of the 950° F. operating temperature, previous reactors had been designed for 1000° F. max., which made the wall thickness 1½ in., using carbon steel plate and a design pressure of 25 psi. Carbon steel has an allowable stress of only 3400 psi. at 1000° F. because of its low creep strength at that temperature. An 85% joint efficiency is used because the vessel would be stress-relieved by initial operation at 950° F. In the interest of economy and a shorter construction period it was decided to reduce the thickness by lowering the design temperature to 975° F., which increased the allowable carbon steel stress to 4175 psi.

Another step in this direction was the decision to radiograph (X-ray) all welded seams, thus insuring a stronger joint with a 95% efficiency. Thus the thickness of the reactor walls was reduced to 1⅛ in. The conical reactor heads were calculated to be 1½ in. thick with an 18-in. knuckle radius and this was cut to 1 in. in the apex course. Another saving was effected by using ordinary A-70 firebox steel instead of A-201 carbon-silicon steel which cost about 1c lb. more.

The actual cost of the reactor under present welded design was $109,500. The cost of a previous welded design using 1½-in. material was $124,000. The cost of a hypothetical 1½-in. riveted reactor was $136,500.

Reactor Grid—The internal equipment in the reactor is essentially the same as in the regenerator, except for the omission of the lining and addition of a compartmental stripping section. The grid beams were constructed of ½-in. carbon-½% molybdenum steel, using an allowable stress of 8125 psi. at 975° F. Actual cost of the grid was $7120; comparable cost of grid constructed of meehanite castings and carbon-moly supports is placed at $10,500.

Reactor Cyclones—Design and construction of the cyclones in the reactor were the same as for the regenerator cyclones except for materials and size. They were made of ⅜-in. carbon steel plates and the support frame was of carbon-moly steel. Weight was 44,000 lbs. and cost $32,000, as compared with weight of 52,000 lbs. and cost of $40,000 by combined forged, cast and riveted construction.

Fractionating Tower

Alloy-Lined Shell—The tower required a diameter of 17 ft. 6 in. to meet the process requirements and the 24 bubble trays and 9 disk and do-nut perforated pans required a total height of 88 ft. 9 in. between tangents. A feature of its construction was a corrosion resistant alloy lining installed to a height of 56 ft. because of the corrosive nature of the product vapors and slurry oil in the bottom of the tower. The lining was 12% chrome alloy material, 7/64 in. thick. It was attached to the carbon steel plates of the shell by a resistance-welding process described as follows in the report:

"This process depends upon the combined use of heat, generated by an electric current flowing across an intended location, and pressure, which is supplied when the metals at the contact area under the two electrodes are plastic from the heat, and are squeezed together to form a homogeneous bond or weld. Its main difference from fusion welding lies in the fact that the joining occurs in the plastic range of the metals, that is, below the melting point of the material being joined.

"In lining a carbon steel plate with a stainless alloy, the steel plate is prepared by surface blasting the one side to be lined, and then joining the liner plate to it by means of the resistance welding process applied on multiple spots spaced about 1½ in. apart. This results in a bond sufficiently strong to resist an air pressure of 100 psi. between base plate and liner, and will withstand all stresses incidental to fabrication into a lined pressure vessel.

"In welding, the steel side is welded with an ordinary carbon steel elec-

trode and on the lined or clad side, with an alloy electrode, in this case 25-20 chrome-nickel, as used on other chrome alloys. The excess alloy content compensates for dilution of the deposited metal from the electrode with small amounts of iron from the steel base. Therefore, the corrosion resistance of the weld is at least as good, if not better, than that of the liner material.

"This is essential because corrosion often attacks stressed areas more violently than elsewhere, and a welded joint usually retains some locked-up stresses due to shrinkage-cooling in the weld, especially when not stress relieved as in this case. All nozzles and mainways in the lined section have to be similarly lined and all alloy liners joined with 25-20 electrodes."

Total weight of the tower, exclusive of internal trays and pans, was 245,000 lbs. and total cost $128,000. For a comparable riveted tower solid alloy plates would have to be used for the bottom section, and the total cost is estimated at $163,000.

The top 16 trays in the less corrosive section were 3/16-in. thick carbon steel plates with heavier supports. The bottom 8 trays and the 9 disk and do-nut pans were specified of 14 U. S. gage alloy No. 405. Total weight of the installation of bubble trays and pans was 202,500 lbs. and the cost $71,200. Comparable equipment of non-welded construction would entail the use of castings. Cast iron trays ⅜ in. thick supported on steel members could be substituted for the carbon steel trays and a corrosion-resistant nickel cast iron on alloy steel supports could be substituted for the alloy steel pans and disks. Weight of such an installation would be around 390,000 lbs. and cost $115,800.

Catalyst Storage Hoppers

In the new Fluid unit the fresh storage hopper was designed for a capacity of one third of the catalyst inventory of 600 tons, or 200 tons. Material was carbon steel, ½ in. thick in the top half, 9/16 in. in the bottom half and ⅝ in. in the bottom cone and skirt.

The larger storage hopper was designed with a capacity equal to the complete catalyst inventory of the unit, or 600 tons. When the unit is shut down for inspection or repairs, it is necessary to transfer all the catalyst from the system into this hopper. Since the catalyst would still be hot, this vessel was designed for a temperature of 850° F. at a pressure of 15 psi. as well as for 25 psi. at 650° F.

While some saving in cost of the catalyst hoppers was realized by welding, a greater saving was achieved in the design and not due to welding. "In previous plants" states the report, "both hoppers had been the same size, that is, the capacity of the larger one. Hence a saving equal to the difference in cost of the two vessels, or $26,000, plus the cost of a screw conveyor between the vessels, can be attributed to this economic improvement, as justified below.

"Since replacement of catalyst due to operating losses does not require a large volume, a capacity of only one-third the inventory was arbitrarily picked for the fresh hopper, and the conveyor system was attached to it only, saving the screw conveyor and the installation of the conveyor filter on top of the large hopper.

"Only for the original startup must the catalyst be transferred from the fresh to the main hopper by compressed air, and the latter completely filled before the contents are injected into the system by means of a catalyst filling line. The main hopper is thus kept empty, ready to store all the catalyst inventory in event of a shutdown, while the fresh hopper is kept filled with catalyst, which is added to the system directly through a catalyst addition line as required. The total saving, including reduction in the supporting structure and foundation, as well as screw conveyor and reduction in fresh hopper, is approximately $35,000."

Catalyst Piping

In previous units the large pipes had been made of carbon steel, lined with a refractory tile as in the regenerator. Imperfect installation, due to difficulty of access, and vibration and erosion caused by high velocity, had caused failure of the lining. A design had also been used employing only insulation between an inner and outer steel wall, with the latter de-

This Month's Cover Picture

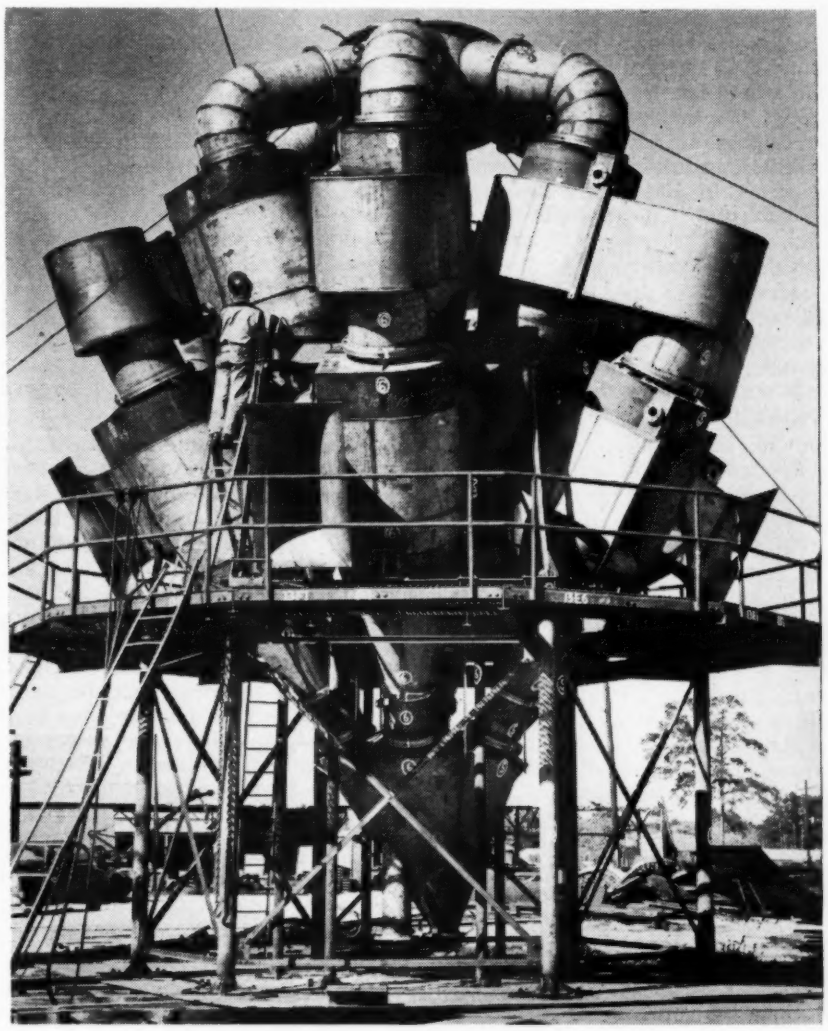


Fig. 5—Multi-cyclone unit being welded in the field. These units consisted of two stages of 6 parallel cyclones each, arranged concentrically and supported on a frame suspended from the top cone of the generator

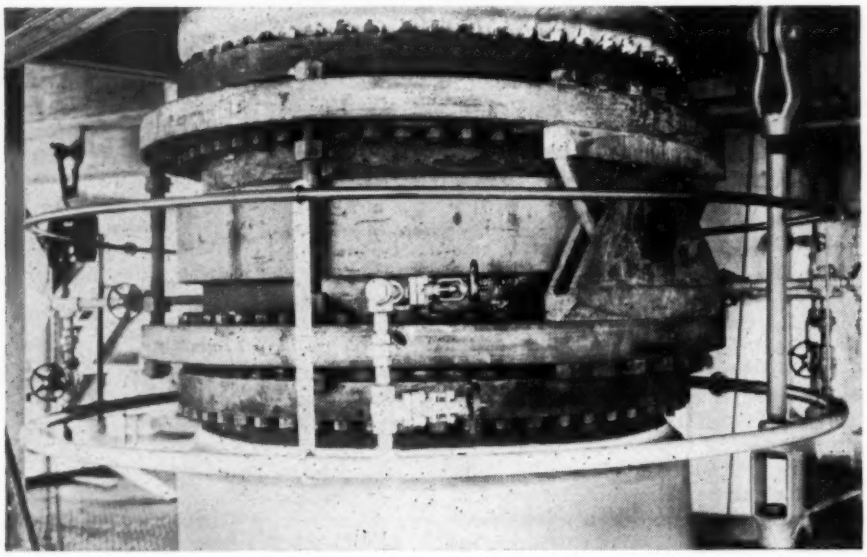


Fig. 6—The special hinged or rotating type expansion joint installed in the catalyst circuit

signed for pressure at lower temperatures and the former free to expand. The difficulty with this design was that the catalyst worked through the inner wall at the expansion slip joints and eroded away the insulation, causing rapidly spreading hot spots in the outer wall, which was not designed for high temperatures.

For the present design it was decided not to use lined pipe but to design an unlined single-wall pipe of suitable material for the high operating temperature with wear plates at bends to allow for erosion.

Carbon-moly steel was selected, as used in the reactor internals and catalyst coolers, with an allowable design stress of 1500 psi. at 1100° F. An erosion allowance of ¼ in. was included, in addition to the wear plates.

In connection with this equipment, the possibility of the graphitization of the carbon-moly pipe welds was considered, in the light of experience with a rupture of a carbon-moly steam pipe near a welded joint. This failure was caused by the carbide in the steel reverting to graphite, which resulted in a weakened, brittle structure of low shock resistance. It has been learned by metallurgists that using silicon as a killing or oxidizing agent instead of aluminum inhibits graphitization, and the carbon-moly plates and pipe used were silicon-killed.

Expansion Joints

Expansion of the piping due to high temperature was taken care of by axial universal or hinged (rotating) expansion joints. Stability and resistance to vibration caused by catalyst surges was secured by counter-weights and guides or snubbers.

A special type of joint developed by the Foster Wheeler Corp. was selected for the catalyst circuits, in the fabrication of which a unique welding process was used. The flexible element consists of a stabilized stainless steel, type 347, multi-disk bellows of 16-gauge thickness which is the key feature of the joints. The bellows is built up by a resistance welding process, which permits alternate welding of the internal and external peripheries of adjacent disks to form a bellows of short face-to-face dimensions, but with large movement and unusual flexibility. Fig. 6 shows the hinged or rotation type expansion joint installed on a catalyst line.

The welding process, in which special machinery is used, is performed under water, which rapidly cools the metal through the critical temperature range, thereby preventing carbide precipitation with a consequent reduction in fatigue life and flexible value of the bellows disk. The stainless steel and disks, which are thicker than the flexible bellows, are through-welded to the main cylinder or spool piece, which in this case was carbon-moly steel. The inner safety sleeve and the external sleeve are normally carbon steel, also welded. The limit stop rods prevent expansion and compression beyond the limits for which the joint is designed. The only non-welded feature is the hinges on the rotation joints, which are steel castings stud-bolted to the end flanges to permit removal.

The savings through welding on numerous items of conventional refinery equipment, partially shop welded and partly welded in the field, are shown in Table 1. In the compressor house, where a rigid frame design was picked, welding was used in the fabrication of the bents. An estimated 20% was saved in weight of steel for the building over conventional riveted truss design.

Other advantages of the use of welding in modern plant construction are summarized as follows in the report:

"Besides economic advantages, engineers choose welding for many reasons, such as strength, durability and improved operation. The very nature of arc welding provides for the joining of two pieces of metal, not necessarily similar, by a filler metal at least as strong, if not stronger, than either piece and of at least equal cross-section; hence, it is automatically as strong, if not stronger, than the adjoining metal, unless welding was done negligently or imperfectly. Tests prove that pressure vessels stressed to destruction usually fail in the solid plate rather than in the welded seam.

"Modifications of arc welding were employed in construction of this unit, but all still relied on an electric arc to create the required heat to produce metallic fusion. Automatic stud-welding was used in the regenerator liner attachment, resistance-welding in the fractionator alloy liner attachment and in the fabrication of expansion joint bellows, submerged meld welding in the fabrication of the catalyst coolers and piping. Every method was particularly well suited to the product at hand. In fact, the latter was often dependent on the availability of the method, as in the case of the expansion joint bellows.

"In piping assemblies, for instance, screwed joints and screwed flanged joints have a very short service life before developing leaks. It has been customary, where screwed piping joints are used, to back-weld with at least one bead of weld metal to insure tightness. This appears to be wasteful and inefficient, because the extra expense of using both methods does not result in the advantages of either one; the joint is not at full strength nor is it removable without chipping. Welding provides a quick method of adding a branch or connection to existing piping, especially if no provision was made originally for such additions or extensions. It is admirably suited to the fabrication of headers with multiple outlets, drip pockets, and other connections, because of the reduction in the number of joints (which might require maintenance) reduction in weight and greater dimensional compactness.

"The attachment of such necessary adjuncts to piping as anchor bases, supports, guides, etc. is also expedited and simplified by welding. As in the catalyst piping, mitre joint welding provides a means of curving the pipe if limitations of space, design or availability of fittings prevent the insertion of a normal pipe bend or welding elbow."

MODERN SOLVENT REFINING OF LUBRICATING OILS

Article 3—Solvent Dewaxing Processes

By V. A. KALICHEVSKY

Consulting Chemical Engineer, Magnolia Petroleum Co., Beaumont

Improved technology has made possible the separation of all types of waxes from oils through the use of selected solvents. In the benzol-ketone process, toluol, because of its special advantages, is being substituted for at least a portion of the benzol, as used with methyl-ethyl-ketone in the composite blend. A method is given for calculating the desirable solvent-to-oil ratio on the basis of simple laboratory tests. Operating techniques of MEK dewaxing are discussed. Propane dewaxing is shown to be particularly applicable to residual stocks. Chlorinated solvents present distinct differences from other dewaxing solvents due to their high specific gravity.

PARAFFIN wax may be separated from the oil by filter pressing. The temperature at which this operation is done corresponds very closely to the pour point of the oil which emerges from the presses provided no diluents are employed. However, with heavy distillates this operation becomes impractical because of the high viscosity of the oil at the low pressing temperatures, and some low viscosity solvent must be added to speed up the process.

Wax is soluble, at least to some extent, in such diluents and the total quantity of wax left in the oil pressed without diluents is usually less than that found when diluents are used. This can be overcome only by employing lower dewaxing temperatures than those required in pressing the undiluted oils. The differential between the pour point and filtering temperatures depends on the properties of the solvent selected for reducing the viscosity of the oil. For many years petroleum naphtha was, and still is, frequently used in commercial plants. However, the high temperature differentials encountered in naphtha dewaxing resulted in the development of modern dewaxing processes where other solvents are employed. Certain solvents may show even negative dewaxing differentials(13) but they are as yet of no practical importance.

While paraffin wax can be separated from the oil by filter pressing, the microcrystalline waxes form a cake which is almost impermeable to the oil and the operation becomes impractical unless special solvents are used. However, these waxes can be separated by centrifuging the chilled oil in naphtha solution, an operation which is not applicable to paraffin wax because it cannot be discharged from the conventional centrifuges not equipped with scrapers.

With the recent advances in petroleum technology all types of waxes can be separated from the oil either by filtering or centrifuging, provided proper solvents and equipment are employed. The best known dewaxing processes using filters are the benzol-ketone and the propane processes while those using centrifuges include the Bari-Sol process and its various ramifications.

Benzol-Ketone Dewaxing Process

In this process the oil, which may be either a residual or a distillate stock, is diluted with the solvent, chilled and filtered. Continuous vacuum filters are normally used although in some of the earlier installations pressure filters were employed.

The solvent is of a composite type. Originally benzol and acetone constituted its two components, but lately toluene is often substituted for a portion of the benzol while methyl-ethyl-ketone has practically replaced the acetone. These solvents are of two distinct types, i.e., aromatic solvents (benzol and toluene) and oxygenated solvents (acetone and methyl-ethyl-ketone). They are sometimes referred to as "solvents" and "anti-solvents" respectively.

Benzol and toluol are excellent solvents for the oil but they are also good solvents for the wax. For this reason if no anti-solvent were employed, the dewaxing temperature differentials would be high. Furthermore the wax cake deposited from these solvents consists of fine, closely packed crystals which are almost impermeable to the liquid phase, making the wax-oil slurry unfilterable. Benzol is less desirable than toluol because of its high melting point. For this reason it precipitates out with the wax if low chilling temperatures are used. Toluol has a further advantage in that at equal concentrations in mixtures with "anti-solvents" it is capable of holding the oil in solution better than benzol. The main reason why it has not completely replaced benzol in commercial practice is its somewhat higher cost.

Acetone and methyl-ethyl-ketone (MEK) are called "anti-solvents" because they do not readily mix with the oil. However, wax crystallizes very well from their solutions on chilling, and is easily filtered and washed free of the occluded oil by applying more solvent. Acetone has greater "anti-solvent" properties than methyl-ethyl-ketone and smaller quantities of it are required to secure desired results when it is blended with benzol or toluol. However, its boiling point is 133° F. as compared to 175° F. for methyl-ethyl-ketone, which results in somewhat higher solvent losses by evaporation. Likewise the methyl-ethyl-ketone is capable of holding the oil in solution better than acetone in oil-wax mixtures having similar filterabilities.

The above shows that the most desirable solvent mixture is that of toluol and methyl-ethyl-ketone. Benzol

is used mainly for economical reasons while acetone is now seldom if ever employed except in small quantities present in commercial MEK. The composition of the benzol-toluol-MEK mixture is normally adjusted to contain the maximum percentage of MEK in order to insure the best possible structure of the wax cake. However, concentration of MEK should be below that at which the oil might be thrown out of solution at the lowest temperatures encountered in plant operations. The optimum combinations of solvents are determined in the laboratory.(14)

The total solvent-to-oil ratio is adjusted so as to obtain the maximum possible output of the dewaxed oil. If viscosity of the solution is high the output is low on account of slow filter rates. If viscosity is very low because of the presence of excessive quantities of solvent, the output is also low as the quantity of oil per unit volume of liquid passed through the filters is reduced below the optimum that must be maintained for securing improved production. This shows that the most satisfactory results are obtained by proper adjustment of the solvent-to-oil ratios.

The method of calculating the desirable solvent-to-oil ratio on the basis of simple laboratory tests has been developed by Reeves.(15) He found that viscosities of commercially encountered solvent-to-oil mixtures containing from 50 to 100% solvent at a constant temperature which corresponds in this instance to the temperature of filtration, is represented by a straight line on a logarithmic paper where absolute viscosities (μ) and volume percentages of solvent in the mixtures (F) are plotted as ordinates. Algebraically this is represented by the formula:

$$\mu = AF^B$$

where A and B are constants.

It may be noted that only two points are necessary for establishing the line and that one of these points might be viscosity of the solvent itself, which reduces the experimental work to the determination of one set of data.

Optimum dilution (F_o) is then found from the relationship derived by application of calculus:

$$F_o = \frac{B}{1 - B}$$

The latter equation may be transformed into the one where the constant B is expressed in terms of the fraction by volume of the undewaxed oil in the solvent mixture charged to the filters (S), and the fraction of wax in the solvent free oil charge (V).

$$S = \frac{F_o}{F_o + \dfrac{1 - F_o}{1 - v}}$$

The above shows that for securing best results on each individual stock both the composition of the solvent mixture and the total solvent-to-oil ratio must be adjusted for each individual charging stock. This is difficult, if not impossible in commercial plant operations. For this reason the best commercial procedure consists of establishing the maximum permissible methyl-ethyl-ketone content of the solvent mixture that can be tolerated in dewaxing any stock that the refinery may process when employing the respective optimum solvent-to-oil ratios.

In other words, the solvent-to-oil ratio is primarily determined by the viscosity desired for filtration or centrifuging, while the composition of the solvent itself—ratio of methyl-ethyl-ketone to benzol-toluol is controlled by (1) the structure of the wax removed and (2) the amount of the ketone which can be tolerated without dissolving enough oil to precipitate a significant amount with the wax.

The dewaxing temperature differential, i.e., the spread between the dewaxing temperature and the pour point of the oil, varies with the pour point of the oil, composition of the solvent mixture, and the type of stock processed. The total volume of solvent employed has a somewhat minor effect because over the normally encountered solvent-to-oil ratios the decrease in solubility of wax per unit volume of the solvent-oil mixture, which is due to its increased solvent content, is almost counterbalanced by the corresponding increase in the total volume of the mixture. For this reason the quantity of wax dissolved in the filtrate remains for all practical purposes constant.

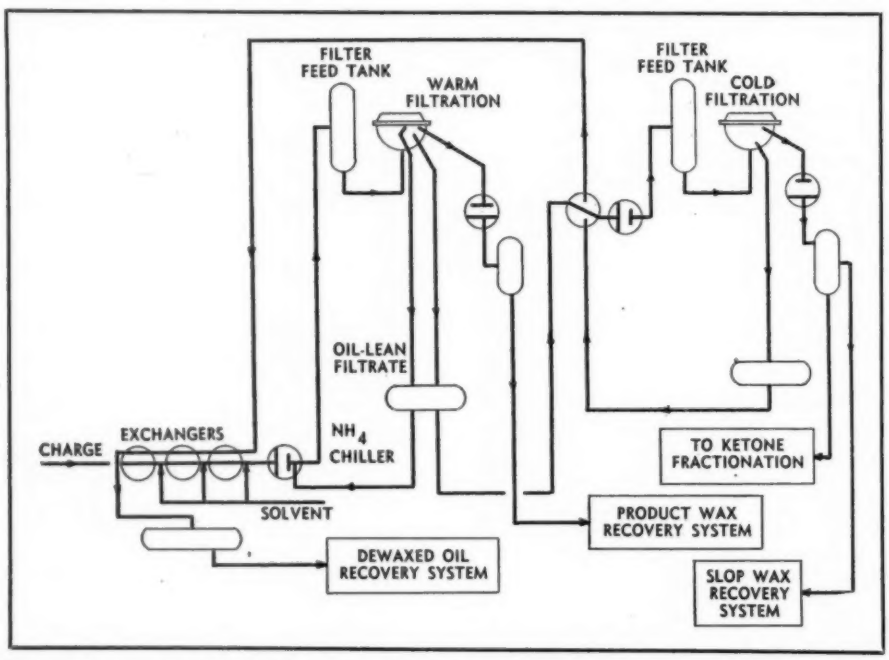
The temperature differential increases with the decrease in the pour point of the oil. This shows that the solubility of wax in the oil-solvent mixture falls off less rapidly with the lowering of the temperature than the effect which the additional trace of wax left in the dewaxed oil may have on its pour point. This temperature differential may be 10° F. or even 5° F. for non-refined oils and about 20° F. for refined oils within the usual pour point ranges.

The method of preparing the solvent-oil mixture, the rate of chilling and the way the solvent is applied to the oil are all of importance although the effect of these variables on the ultimate result is considerably less pronounced than in conventional naphtha dewaxing.

The solvent-oil mixture is heated to a temperature which may be in some instances 50-60° F. higher than that necessary to effect complete dissolution of wax. This is done in order to insure that no possible aggregates of wax molecules may be present in the solution which could affect the structure of the wax crystals that are formed on subsequent chilling.

The rate of chilling may be as high as 25° F. or 35° F. per hour as compared to 1-2° F. per hour when naphtha is employed. However, still higher chilling rates may have an unfavorable effect on the filterability of the wax cake.

The method of applying solvent to



Flow diagram of the MEK process as employed in the Pennzoil lube oil refinery at Oil City, Pa. (original drawing courtesy Arthur G. McKee & Co.)

the oil is of importance. Two extremes are possible, namely all the solvent, except that required for washing filters, may be mixed with the oil before chilling or the oil may be chilled to the dewaxing temperature in the absence of solvent and then diluted with the solvent just before it is passed to the filters. The second method is best for securing the lowest possible oil content of the wax cake and increasing the oil recovery.(16) However, the filter rates are unfavorably affected because wax crystallizes in the most desirable form in the presence of MEK.

The so-called double-dilution method of applying the solvent is a compromise between the two extremes. The oil is mixed with only a portion of the solvent and chilled before the remaining solvent is added. As might be expected from the previous discussion, the filtering rates are somewhat lower while the oil content of the wax cake is higher than those observed when all of the solvent is mixed with the oil before chilling.

In studying the double dilution method Reeves and Pattillo(17) found that the advantages of the two extreme operating methods may be combined by varying the composition of solvent used for primary and secondary dilution. This is done by employing all of the methyl-ethyl-ketone in the primary solvent and the amount of benzene and toluene that is absolutely necessary to effect complete dissolution of the oil while the remaining benzene or toluene is used for secondary dilution. Unfortunately, existing plant design and operating difficulties prevent this method from being adopted commercially.

Filters used in the benzol-ketone process are of the continuous vacuum type. They are cylinders separated into compartments having their apexes at the cylinder radius. Some of the compartments are immersed in the solvent-oil-wax slurry. At this point vacuum is applied from inside to build the cake of desired thickness. When the cake emerges from the slurry, a chilled solvent is sprayed on it in order to displace as much as possible of the solvent-oil solution occluded between the wax crystals. Vacuum is then discontinued and the cake is separated from the canvas by scrapers, before beginning the next cycle. All operations are automatic. In the past, pressure filters were occasionally employed but their use has been practically discontinued.

A number of problems arise in the operation of filters. Filter rates are highest when the thickness of the wax cake is smallest. However, if this thickness is less than a certain minimum the scrapers may not be able to remove the cake because of the slight space existing between the blades and the canvas. Therefore the thickness of the cake should be maintained at the level at which it can be just removed from the canvas.

Increase in filter capacity can be obtained by certain adjustments of the equipment and by changes in operating technique. Adjustments of the equipment may consist in varying the number of sections of the filter which are submerged in the solvent-oil-wax slurry and in changing the speed of filter rotation assuming that the scrapers are set as close as possible to the canvas without causing unnecessary wear and tear. The change in the number of submerged sections is a relatively complicated procedure and cannot be considered as one of the variables which the operator can alter at will. It is usually adjusted by the filter manufacturer so as to provide sufficient time for completing the filter cycle by properly proportioning the cake washing and cake removing operations. However, the rate of filter rotation can be adjusted with relative ease. In treating various stocks the rate is determined at which the wax is deposited on the canvas so that the minimum permissible thickness of the cake is maintained at all times.

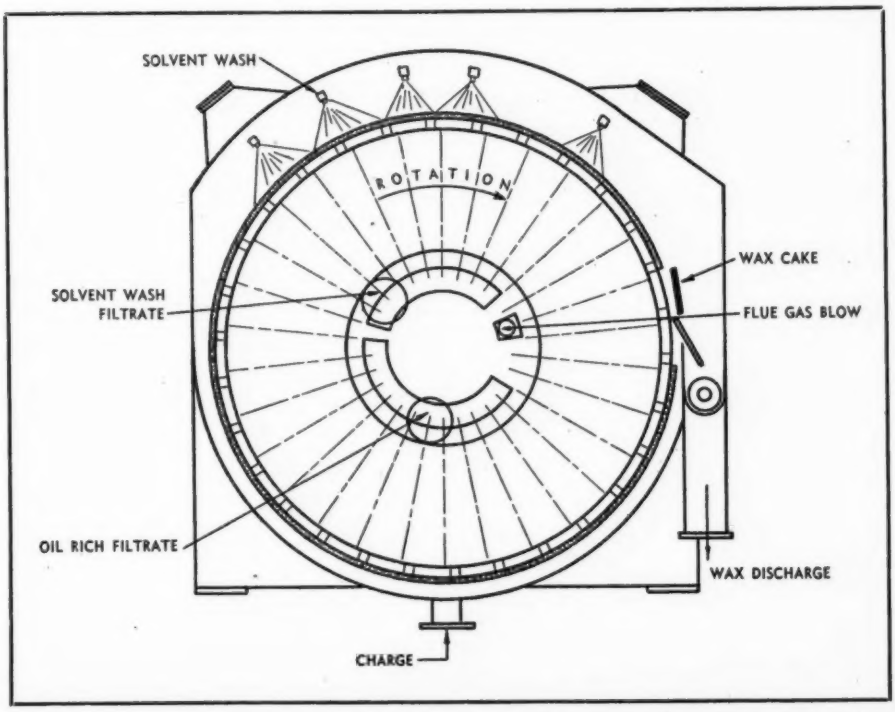
Because of the constant immersion of filters it is not always possible to secure the desired wax cake thickness within the rotational filter speed limits. For these reasons in dewaxing certain stocks either too much or too little of the wax may be deposited. Recirculation of filtrate or wax may then be resorted to so as to maintain the wax content of the oil-solvent-wax slurry at the desired level.

Reeves(18) has demonstrated, however, that such recirculation does not generally increase the filter output and should not be used indiscriminately. Washing of canvas on the filters is done occasionally by applying preferably a warm solvent. The time between washings depends to a great extent on the type of stock processed and should be adjusted accordingly.

The above discussion shows the existence of a very large number of variables in solvent dewaxing operations. In analyzing commercial operations considerable caution must be exercised in isolating them because otherwise undue weight may be assigned to a variable which may be of very little practical importance. This is apt to occur when more than one variable is changed at the same time though this cannot always be avoided because of inherent equipment limitations.

Propane Dewaxing Process

This process involves propane as a solvent for reducing viscosity of the oil and to improve the crystal structure of wax. Solubility of paraffin wax increases with the decrease in the molecular weight of the hydrocarbon and on this basis the heavy hydrocarbons or high boiling point naphthas are preferable to propane. However, the quantity of propane needed to reduce viscosity of the oil to the desired level is less than that of the heavier hydrocarbons, and for



Cross sectional diagram of the Conkey solvent dewaxing filter used in the MEK process (original drawing courtesy the Lummus Co.)

equal volumes of such solvents used for diluting the charge stock, viscosities of propane solutions are consequently considerably lower. The wax crystals obtained from propane solutions have better filtering characteristics than those separating from naphtha. This may be ascribed to the inherent properties of propane itself and might be explained both by its higher solvent power towards paraffin wax and the lower viscosity of solutions. The effect of these two factors on the velocity of growth of wax crystals is well known.(19)

Propane boils at −48° F. and must be liquefied by applying pressure when employed as a dewaxing solvent. This necessitates installation of powerful compressors and the use of pressure equipment. However, a number of advantages are derived from these very same disadvantages. Propane can easily be separated from the oil or wax because of its high volatility, and the mixture of propane and oil may be chilled merely by evaporating a portion of propane thus eliminating the necessity of employing auxiliary refrigeration equipment and exchangers which always involve losses in the expensive Btu.'s of "cold".

The propane process is particularly applicable to residual stocks although it is claimed that satisfactory results are obtained with the distillate oils containing paraffin wax. The oil charge is blended with about three volumes of liquid propane at about 180° F. under pressure in order to completely dissolve all the wax, for reasons already explained under the benzol-ketone process. The use of smaller volumes of propane, particularly below 2.0 or 1.5 volumes per volume of oil, is not recommended on account of possible gel formation and unsatisfactory structure of separated wax crystals. This is in accord with the previous assumptions that the action of propane is in line with that which might be expected from its position in the hydrocarbon series and might be explained on the basis of its viscosity and solubility characteristics.

The oil-propane mixture is chilled to approximately 70° F. by passing it through exchangers countercurrently to the cold oil solution leaving the filters. Further reduction in temperature is effected by direct evaporation of a portion of propane from the solution by reduction of pressure. This is done in special chillers operated on the continuous batch principle. Slight agitation of the mixture is desirable but excessive stirring is harmful because of the possibility of breaking the wax crystals. The rate of chilling is much faster than that which must be maintained with naphtha and is similar to that used in other solvent dewaxing processes.

The chilled propane-oil-wax slurry is fed to vacuum filters of a design similar to the one described in connection with the benzol-ketone process. Pressure filters are gradually being abandoned.

The use of the dewaxing assistants, which are also referred to as wax modifiers or crystallization regulators, is sometimes recommended in connection with the solvent dewaxing processes, particularly with propane. These dewaxing assistants are used in very small quantities, usually less than 0.2% based on the above oil charge. They are represented by some of the pour point depressants like Santopour or Paraflow or substances like microcrystalline wax, asphaltic constituents and a number of others.

From the above discussion it may be seen that most of the operating variables which were fully described in connection with the benzol-ketone process exist in propane dewaxing with the exception that a single solvent and not a mixture of solvents is employed. For this reason their further analysis is omitted.

Chlorinated Solvent Dewaxing (Bari-Sol Process)

Chlorinated solvents present certain distinct differences from the previously described dewaxing solvents which are due mainly to their high specific gravity. This difference in gravity permits an easy separation of the wax and oil layers by centrifuging.

The solvents used may be a single solvent as represented by trichloroethylene, or "tri", or a mixture of solvents, like ethylene dichloride and benzol. Trichloroethylene has better miscibility characteristics towards the oil than ethylene dichloride which must be blended with benzol in order to prevent separation of the oil at the dewaxing temperatures. The phenomena involved were mentioned in connection with the benzol-acetone process.

When trichloroethylene is employed about 2/3 to 1½ volumes of solvent are used per one volume of oil. Mixing is done in a column at about 100-120° F. The chilling rate is 10-15° F. per hour although in some instances it is lowered to about 8° F. per hour. This chilling rate is not necessarily uniform and may be higher after temperatures below 32° F. are reached and the crystals are formed than before. This is in accordance with similar experiences in naphtha dewaxing where the rate of chilling may be high before crystals begin to form and after they are well defined but slow while their separation is taking place.

Addition of benzol to ethylene dichloride is controlled by the same considerations as those mentioned in connection with the benzol or toluol and methyl-ethyl-ketone blends. The usual refinery mixture contains 22% vol. benzol and 78% vol. ethylene dichloride subject to the above limitations. About three volumes of this mixed solvent is used per one volume of oil. Blending is done in agitators at about 110° F. However, the use of various equipment for securing uniform mixtures of oil and solvent at such temperatures is controlled by practical considerations and convenience and not by their effect on the structure of wax crystals which have not yet begun to form.

The dewaxing temperature differential for the above solvents may be 10-20° F. or higher, subject to the limitations described in connection with other solvents. The chilled solution is discharged to centrifuges where the wax and oil phases are separated. While in naphtha centifuging the wax layer separates at the periphery of the machine, it appears as the inner layer when the chlorinated solvents are employed because of the difference in gravity between the two oil solvents. This difference in gravity is also of such magnitude that the centrifuges can be operated at a relatively low speed of 8000-9000 RPM. instead of 15,000-17,000 RPM. when naphtha is employed.

The wax layer discharged from the centrifuges contains certain quantities of oil, as is common to other dewaxing processes. The oil is separated from the wax phase by diluting it with additional quantities of solvent and recentrifuging at somewhat lower temperatures. The resulting oil-free wax is recovered while solvent containing the extracted oil is employed for diluting the fresh batch of the charge stock. A similar method for producing wax free of oil has been developed also in connection with the benzol-acetone process where slack wax is sometimes reprocessed on a separate series of filters.

The chlorinated solvents are removed from the oil by distillation. Trichloroethylene is distilled off in the presence of steam at a temperature not exceeding 265° F. in order to avoid corrosion of equipment. A maximum temperature of 290° F. is usually specified for ethylene dichloride.

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First Use of Centrifugal Compressors For Dewaxing Plant Refrigeration

THE 4600 b/d (nominal capacity) Benzol Methyl-Ethyl-Ketone dewaxing unit of Humble Oil & Refining Co, at its Baytown refinery, is the first solvent dewaxing plant in the country to install centrifugal compressors. Propane is used for the refrigerant.

The new MEK unit, shown in Fig. 1, virtually doubled the refinery's output of premium motor oil. Yet Baytown's total motor oil production remained subtantially constant, because the entire gain of high quality oil was at the expense of the output of intermediate quality oils.

Two centrifugal compressors, one a standby, furnish the 765 tons per day (equivalent of melting ice) of refrigeration required to operate the plant. They are driven by steam turbines. Each is a 1900 brake-Hp. unit, runs at 9200 rpm. and is the fastest-moving rotating equipment in the refinery. The single compressor shown in Fig. 2 handles 1400 lbs. of propane per minute, picking it up at 25 psia. for compression to 200 psia. and discharging to the chiller coils through which the solvent-waxy oil mixture passes.

Several advantages are found in using centrifugal rather than reciprocating compressors in this application. The first is size. A favorite plant simile is that one centrifugal is equal to a whole shed full of the other type. It is estimated that eight 250 Hp. reciprocating compressors would be necessary to replace one of the centrifugals at the new plant, any one requiring considerably more space than the centrifugal and its accessories. While not as much standby compressor capacity would be required if reciprocators were used, the initial capital investment, space requirements, low maintenance cost and reduced operator attention tipped the scales in favor of the centrifugals in the Humble installation.

In basic design Humble's installation is no different from other benzol-MEK plants over the country. The first step is mixing the oil with a controlled amount of solvent, primarily to dilute the oil and prevent the mixture from freezing solid when chilled; but, equally important, to preferentially dissolve oil rather than wax at the temperature selected for dewaxing. This requires adjusting solvent composition—ratio of benzol and toluol mixture to MEK—to optimum values for the particular feed stocks being processed. Likewise, the ratio of solvent-to-oil must be such that the minimum amount of wax will be dissolved in the finished oil while, at the same time, the wax will contain a minimum amount of oil when separated during filtration.

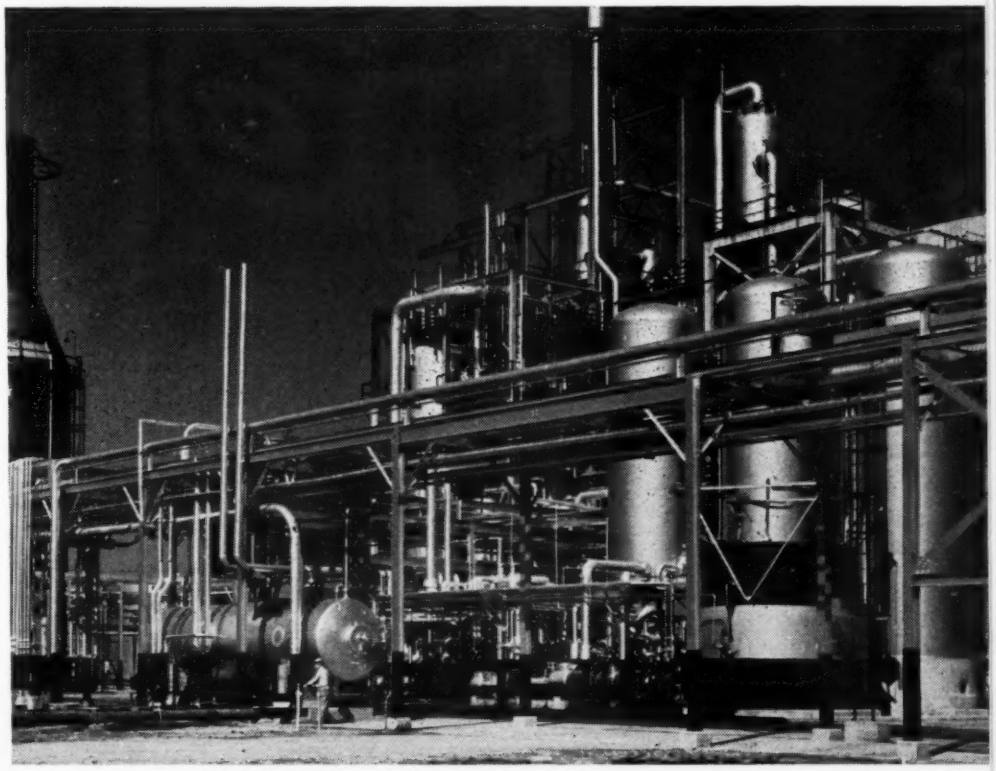
Thus careful laboratory and pilot plant evaluation of a stock ahead of commercial processing is necessary. Accurate control of temperatures, mixing conditions, flow rates and the like are vital in the plant. For the former purpose, Baytown has installed a small experimental unit which duplicates operating conditions of the full-scale equipment. Laboratory investigations evaluate new crudes as possible sources of lube stocks, develop new or modified processing conditions to improve yields and oil quality, and make data available for cost studies of processing operations.

To assure close control of operating variables in the full scale unit, the plant is run by remote control instruments from a central control room. A minimum of operator attention is required and only five men on each shift are required to keep the plant running smoothly.

High Dewaxing Temperature

The usual dewaxing temperature at the new MEK plant is —7° F. By comparison, at an adjacent propane dewaxing unit the normal dewaxing temperature is in the neighborhood of —44° F. The dewaxed oil from the MEK plant has a lower pour test than that from the propane unit, however, despite the higher dewaxing temperature. Since refrigeration generally is expensive, savings are

Fig. 1—Humble's 4600 b/d MEK dewaxing plant glistens in a new coat of paint. At far left is a double-coil heater, which evaporates solvent from dewaxed oil and wax; the horizontal tank contains plant "slops"; in center background are solvent stripper towers. Tanks at right hold oil, wax and solvent. The gas-holder under the pipe-rack contains inert gas for blanketing the equipment



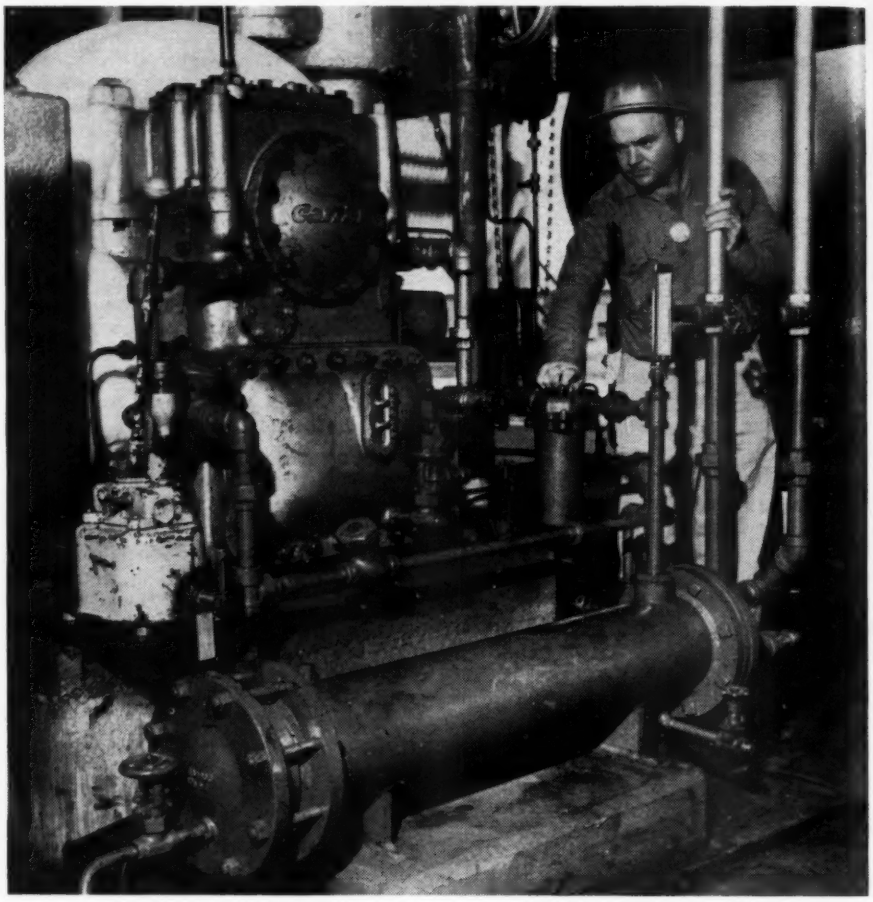


Fig. 2—The first centrifugal compressor installed in a lube dewaxing plant. This unimpressive-looking 1935 Hp. unit runs at 9200 rpm, compresses 1400 lbs. of propane per minute from 25 psia. to 200 psia.; provides 765 tons of refrigeration per day

thus achieved in direct operating costs.

On the other hand, MEK dewaxing requires an elaborate system of scraped-surface chillers and exchangers to chill the oil-solvent mixture by indirect refrigeration. In the propane process, the solvent propane itself is evaporated to provide refrigeration and the equipment to accomplish this is simpler.

The wax recovered by distillation from the solvent in the MEK process is slack wax; that is, it contains a certain amount of oil which must be removed before it is salable in the various commercial grades. This is accomplished elsewhere in the refinery.

Likewise, dewaxed oil from the MEK unit is far from finished. In fact, dewaxing may be about the first step after the lube oil fraction has been distilled from the crude oil. The dewaxed oil still must be conventionally or solvent refined to achieve other desired qualities, such as carbon residue and viscosity index, before it is ready for blending with other components and sale to the consumer. Some refiners, however, dewax as the last step prior to blending and compounding.

Refrigerating the feed stock in double-pipe coils interposed another operating problem, that of preventing the depositing of wax inside the pipes and eventually plugging them.

The wax cannot be prevented from depositing on the pipes, so a set of rotating knives or scrapers of improved design on a rotating shaft is installed inside each pipe to remove the wax coating as rapidly as it forms. The coils are contained in an insulated box to reduce refrigeration requirements. Glass-covered peep-holes are provided in the box at the end of each shaft opposite the driven end, as shown in Fig. 3, permitting the operator to inspect the end of each pass of piping. If the shaft is revolving, the knives are working properly.

From the chillers the cold, waxy oil passes to continuous vacuum filters. Here the wax is deposited on a canvas-like filter cloth around the slowly-revolving drum. The drum is divided into 18 sections, one group of which are immersed in the waxy oil, the next being washed with fresh solvent to remove most of the oil remaining in the wax, and the third being relieved of its waxy coat by scrapers, whence the cycle is repeated. One of these units will filter far more oil in a day than the old leaf type which used to be the standard dewaxing plant filtration equipment.

The chilled oil, now wax-free, gives up most of its refrigeration to incoming feedstock. It then is heated and the solvent stripped and condensed for return to process. The oil now is ready for further refining. The wax removed from the filters is similarly freed of solvent and then pumped as a liquid to storage for further processing.

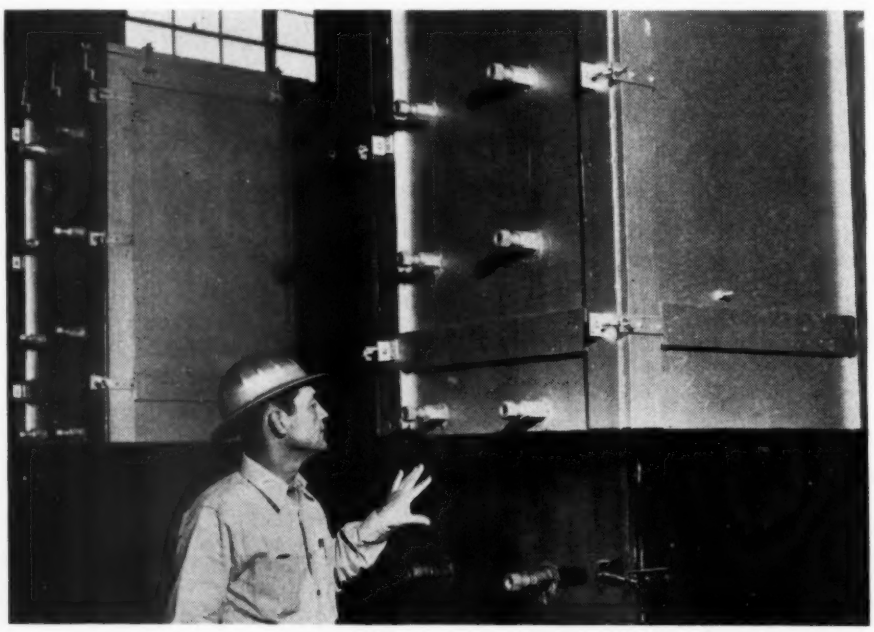


Fig. 3—Modern version of the lookbox. The operator really is inspecting the scraping mechanism in this double-pipe chiller, which cools the oil-solvent mixture to —7°F before the dewaxing operation

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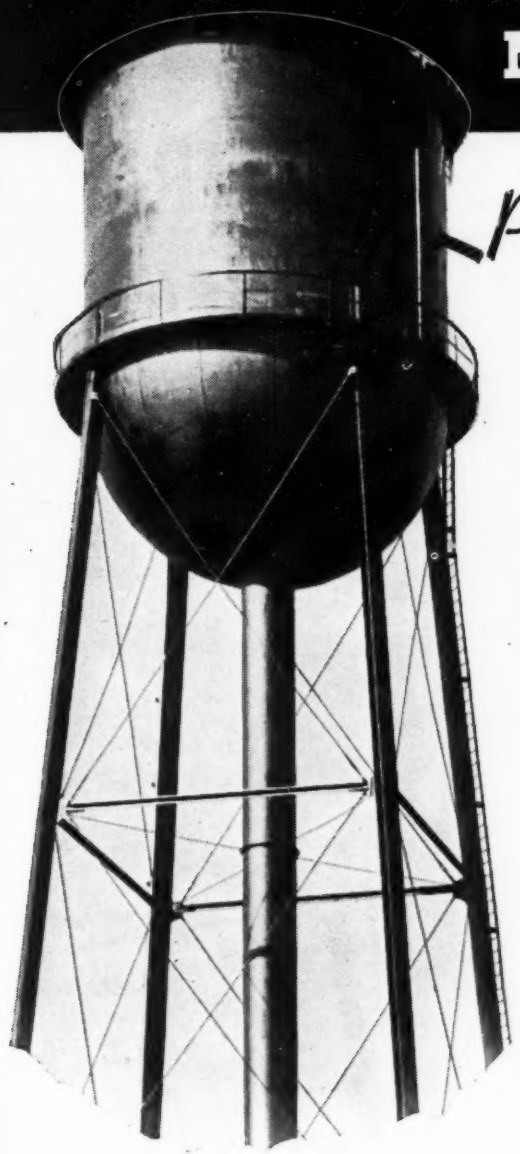

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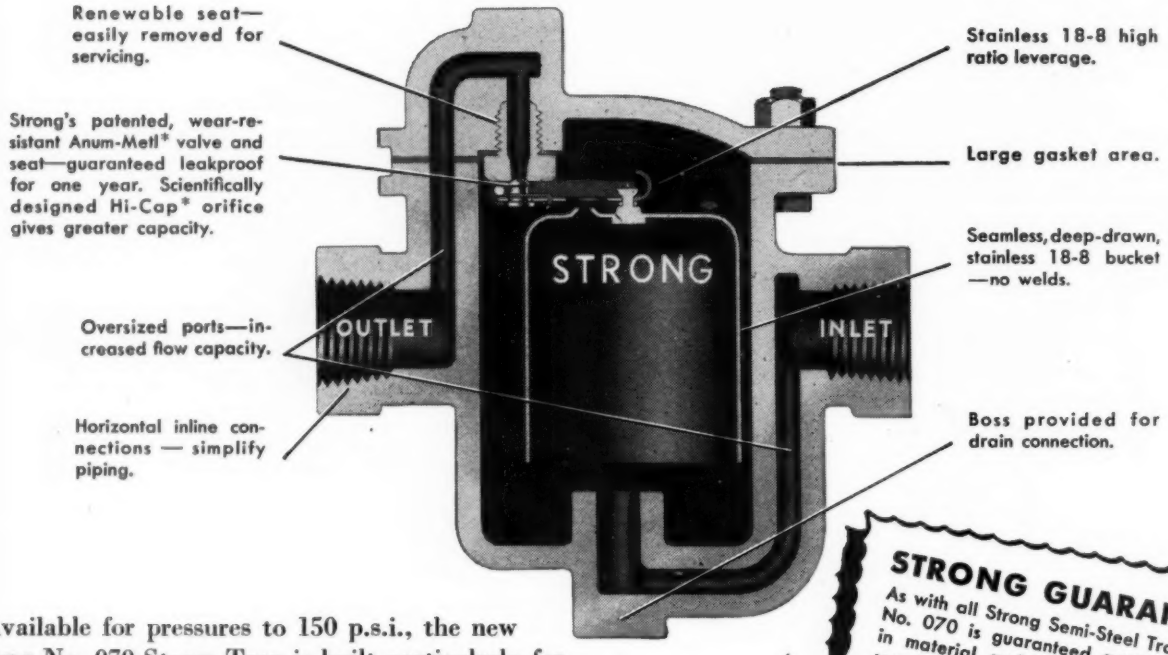
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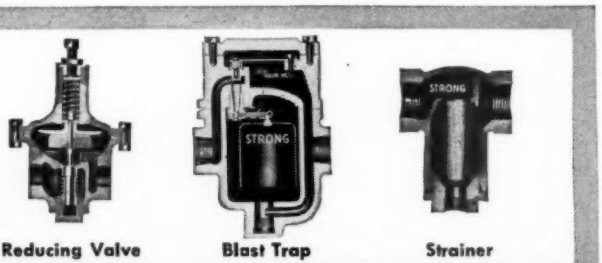

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Short Cut Process Design to Increase Propane Recovery in Gasoline Plants

By ALAN S. GLENDENING and CHARLES F. SANDERSON
Sanderson-Glendening, Consulting Engineers, Houston

Article 2

In this article, the second of a series dealing with the design of various portions of natural gasoline and cycling plant facilities, the authors apply the methods developed in the first article (Petroleum Processing, Jan., 1949, pg. 27) and present an example of the design of a de-ethanizer.

The primary aim of this series is to develop for the reader rapid design methods which will give sufficient accuracy for basic design assumptions, estimating purposes, and economic studies, particularly where several approaches may be under consideration. Emphasis is placed on methods employing algebraic formulations, rather than graphical solutions and highly accurate but generally detailed and time-consuming calculating procedures.

The liquid and vapor of Table 1 is to be fed to a rich oil de-ethanizer. The two phases are in equilibrium for the purposes of simplicity in this example. In practice, however, the vapor portions of the feed could be derived from several different sources and as a consequence may not be in equilibrium with the liquid portion.

The unit is to operate at 200 psig. Lean oil enters the absorption section at 90° F, and warms to 110° F. at point "b." Feed enters at 200° F. and a reheater at the base of the column keeps the stripping section temperature practically constant at this value. Otherwise it is assumed to have no appreciable effect on the separation and the small amount of vapors it evolves constitute a small additional safety factor for the stripping section. Recovery of propane in the feed is to be 85 mol-% and ethane inclusion in the bottoms is allowed to equal 3 mol-% of propane in the bottoms. Steam stripping is to be employed, but practically all the steam will be condensed and the vapors cooled to 90° F. prior to entering the absorption section. The tower will be assumed to have ten theoretical absorption plates and ten theoretical stripping plates. The Massachusetts Institute of Technology equilibrium curves will be used:

For propane:

$$l_M = 0.85(73.5 + 63.9) = 116.8$$

For ethane:

$$l_M = 0.03(116.8) = 3.5$$

(Editor's Note: The nomenclature used in design calculations and graphical solutions in this article is given on pg. 160.)

	Ethane	Propane
l_M	3.5	116.8
l_f	30.0	73.5
v_f	67.8	63.9

All the above values are obtained from statement of the problem. The values of E_a and E_s are determined as shown in Table 2. It is necessary to assume a value to start, and in this case the E_a for propane is assumed to be 0.90. The value of A for propane is obtained either from Equation 4 or from the absorption factor charts previously mentioned, using ten theoretical plates as stated in the problem. A for ethane is obtained by an inverse proportionality of the K's evaluated at the conditions at the base of the absorption section.

The E_s for ethane is then computed by using Equation 15, and the corresponding S obtained from Equation 5 or the absorption factor charts. The S for propane is obtained by a direct proportionality of the K's evaluated at the conditions at the top of the stripping section. The value of 0.440 for the E_s of propane is substituted into Equation 15 to give a second approximation of 0.868 for the E_a of propane. The entire procedure is repeated and a value of E_s is obtained for propane. Since this value differs only slightly from the first trial value, we will use the E_a and E_s for ethane and propane from this trial as the basis for further calculations.

In Table 3 the values for l_c and l_M are calculated for all components. In this table, as in the trial-and-error calculations of Table 2, the K_a's are evaluated at the bottom of the absorption section (200 psig. and 110° F) and the K_s's are evaluated at the top of the stripping sectin (200 psig. and 200° F). Values of S for the non-key components are related to those of the key components already established by a direct proportionality of the K_s's.

Similarly, the values of the A's for the non-key components are related to those of the key components by

TABLE 1—Feed Composition, Mols/Hr

Component	Liquid (l_f)	Vapor (v_f)
Methane	17.4	161.0
Ethane	30.0	67.8
Propane	73.5	63.9
i-Butane	27.0	13.3
n-Butane	58.4	23.9
i-Pentane	22.6	4.9
n-Pentane	30.2	5.6
Hexanes-plus	31.6	1.4
	290.7	341.8
Lean Oil	490.0	neg.
	780.7	341.8

TABLE 2—Trial-and-Error Calculations, Key Components

Trial No.	Component	E_s	S	K_s	E_a	A	K_a
1	Ethane	0.957	1.143	5.2	0.354	0.354	2.8
	Propane	0.440	0.440	2.0	0.900	0.980	1.01
2	Ethane	0.955	1.134	5.2	0.334	0.334	2.8
	Propane	0.436	0.436	2.0	0.868	0.924	1.01

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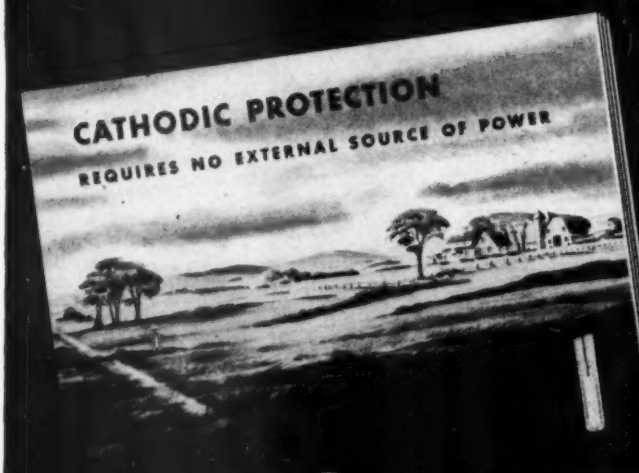

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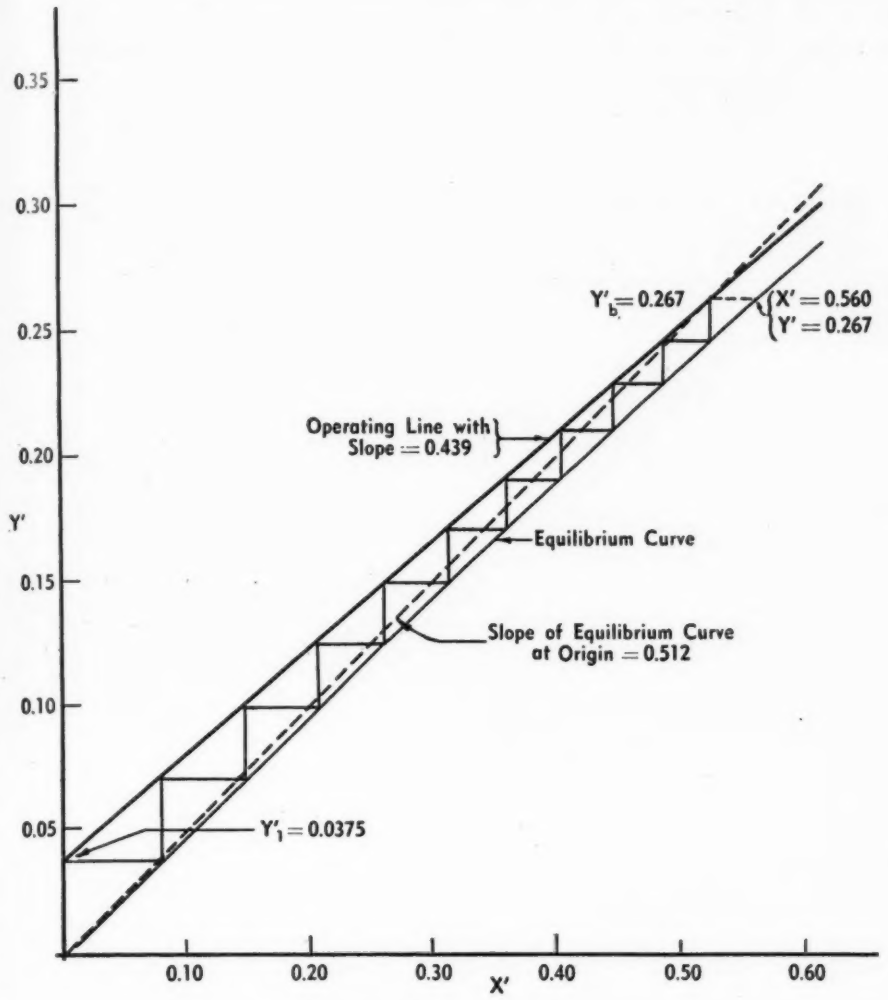


Fig. 5—Propane absorption curve

an inverse proportionality of the K_a's. Once the S's and A's have been found the E_a's and E_a's are found from the equations given or from the absorption factor chart, using M and N equal to ten theoretical trays. The quantities in Equations 13 and 15 are evaluated, and the values of l_c and l_M found for each component.

The components may be totaled at various important points in the column:

$$\Sigma v_1 = \Sigma l_f + \Sigma v_f - \Sigma l_M$$
$$= 290.7 + 341.8 - 339.2 = 293.3$$

$$\Sigma v_c = \Sigma l_c - \Sigma l_M$$
$$= 575.7 - 339.2 = 236.5$$

$$\Sigma v_b = \Sigma v_c + \Sigma v_f$$
$$= 236.5 + 341.8 = 578.3$$

$$\Sigma l_b = \Sigma v_b - \Sigma v_1$$
$$= 578.3 - 293.3 = 285.0$$

Determine lean oil to the absorption section:

At base of absorption section

$$A = \frac{L}{K \cdot V} = \frac{L_a + \Sigma l_b}{K_a \Sigma v_b};$$

A for propane is 0.924 (from trial-and-error calculations), therefore:

$$L_a = (AK_a \Sigma v_b) - \Sigma l_b$$
$$= (0.924)(1.01)(578.3) - (285.0)$$
$$= 254 \text{ mols/hr.}$$

Determine stripping vapor to the stripping section:

At base of stripping section

$$S = \frac{K \cdot V}{L} = \frac{K_s(\Sigma v_c + V_s)}{L_f + L_a + \Sigma l_c};$$

S for propane is 0.436, therefore:

$$V_s = \frac{(L_f + L_a + \Sigma l_c)S}{K_s} - \Sigma v_c$$
$$= \frac{(490 + 254 + 576)\ 0.436}{2.0} - 236.5$$
$$= 51.5 \text{ mols/hr.}$$

The L/V ratios throughout the column are:

At top of absorption section:
$254/293 = 0.867$

At bottom of absorption section:
$(254 + 285)/578 = 0.933$

At top of stripping section:
$(490 + 254 + 576)/(236.5 + 51.5) = 4.59$

At bottom of stripping section:
$(490 + 254 + 339)/51.5 = 21.0$

It is seen that in the absorption section the liquid to vapor ratio is nearly constant, so little correction will result from further refinement of the method. However, in the stripping section the ratio varies very markedly from top to bottom of the section, so the corrections to be applied may be expected to have a correspondingly large influence on the final answer. The method will be illustrated by revising the equilibrium curves and thereby obtaining a corrected E_a for propane and E_s for ethane.

For propane:

From Equation 16 we have found that the slope of the equilibrium line at the origin (lean end of the absorption section) is $K_a(\Sigma Y'_1)$. The slope of the operating line is $L_a/\Sigma v_b$. Converting to these stoichiometric units:

$$Y'_b = v_b/\Sigma v_b$$
$$= (l_c - l_M + v_f)/\Sigma v_b$$
$$= (207.0 - 116.8 + 63.9)/578.3$$
$$= 0.267$$

$$\Sigma Y'_b = 1$$

$$1 + \Sigma X'_b = 1 + \Sigma l_b / L_a$$
$$= 1 + 285/254$$
$$= 2.12$$

TABLE 3—Design Calculations for Algebraic Method

Component	l_f	v_f	E_s	S	K_s	E_a	A	K_a	$1-E_aE_s$	$l_f+E_av_f$	l_c	$1-E_s$	l_M
Methane	17.4	161.0	1.0	4.62	21.2	0.0667	0.0667	14	0.9333	28.1	30.1	0.000	0.0
Ethane	30.0	67.8	0.955	1.134	5.2	0.334	0.334	2.8	0.681	52.6	77.3	0.045	3.5
Propane	73.5	63.9	0.436	0.436	2.0	0.868	0.924	1.01	0.622	128.9	207.0	0.564	116.8
i-Butane	27.0	13.3	0.246	0.246	1.13	1.00	1.867	0.50	0.754	40.3	53.5	0.754	40.3
n-Butane	58.4	23.9	0.205	0.205	0.94	1.00	2.46	0.38	0.795	82.3	103.6	0.795	82.3
i-Pentane	22.6	4.9	0.109	0.109	0.50	1 00	...	...	0.891	27.5	30.9	0.891	27.5
n-Pentane	30.2	5.6	0.094	0.094	0.43	1.00	...	...	0.906	35.8	39.5	0.906	35.8
Hexanes—+	31.6	1.4	0.022	0.022	0.099	1.00	...	...	0.978	33.0	33.8	0.978	33.0
Totals	290.7	341.8									575.7		339.2

In equilibrium with Y'_b:

$$X' = (1+\Sigma X'_b)\,Y'_b/K_a\Sigma Y'_b$$
(from Equation 16)
$$= (0.267)\,(2.12)/(1.01)\,(1.0)$$
$$= 0.560$$

Slope of equilibrium line at origin:

$$K_a\Sigma Y'_1 = K_a(\Sigma v_1/\Sigma v_b)$$
$$= 1.01\ (293.3/578.3)$$
$$= 0.512$$

Slope of operating line:

$$L_a/\Sigma v_b = 254/578.3$$
$$= 0.439$$

Fig. 5 has been constructed in accordance with the above values. Note that the equilibrium curve, as expected, has very little curvature. The operating line is so placed as to allow ten theoretical plates to be stepped off. From the figure:

$Y'_1 = 0.0375$; or

$$v_1 = 0.0375\,(578.3)$$
$$= 21.7$$

Therefore, the percent absorbed is:

$$E_a = (v_b - v_1)/v_b$$
$$= \frac{l_c - l_M + v_f - v_1}{l_c - l_M + v_f}$$
$$= \frac{207.0 - 116.8 + 63.9 - 21.7}{207.0 - 116.8 + 63.9}$$
$$= 0.860$$

This compares well with the value for E_a in the original calculations of 0.868. Therefore, an L_a of 254 is sufficiently close to being correct to be used in the following calculations on the stripping of ethane.

From Equation 17 we find that the slope of the equilibrium line at the lean end of the stripping section is $K_s/\Sigma X''_M$. The slope of the operating line is $(L_a+L_r+\Sigma l_r)/V_s$. Converting to these stoichiometric units gives:

$$X''_M = l_M/(L_f+L_a+\Sigma l_r)$$
$$= 3.5/(490.0+254.0+575.7)$$
$$= 0.00265$$
$$X''_c = l_c/(L_f+L_a+\Sigma l_r)$$
$$= 77.3/(490.0+254.0+575.7)$$
$$= 0.0585$$
$$\Sigma X''_c = 1.0$$

The procedure is to assume a value for V_s such that the operating line obtained by the assumption gives the above X''_M with ten theoretical plates. Assume V_s to be 175 mols.

Then:

$$1+\Sigma Y''_c = 1+(\Sigma v_c/V_s)$$
$$= 1+236.5/175$$
$$= 2.35$$

In equilibrium with X''_c:

$$Y'' = K_s X''_c\,(1+\Sigma Y''_c)/\Sigma X''_c$$
(from Equation 17)
$$= (5.2)\,(0.0585)\,(2.35)/(1.0)$$
$$= 0.715$$

Slope of the operating line:

$$(L_f+L_a+\Sigma l_c)/V_s$$
$$= (490+254+576)/175$$
$$= 7.54$$

Slope of equilibrium line at origin:

$$\frac{K_s}{\Sigma X''_M} = \frac{K_s(L_f+L_a+\Sigma l_c)}{(L_f+L_a+\Sigma l_M)}$$
$$= \frac{5.2(490+254+576)}{(490+254+339)}$$
$$= 6.33$$

Figure 6 has been constructed in accordance with these figures. Since ten theoretical plates are used and X''_M very closely approximates 0.00265, the assumption of V_s was a good one.

This new and higher value of V_s will result in a larger stripping factor for propane and in turn will require a larger propane absorption factor and oil circulation. The stripping factor for propane at "c" is now

$$\frac{2.0(236.5+175)}{490+254+576} = 0.624$$

Then the E_s for propane is 0.624 (from the absorption factor chart).

Using Equation 15 for propane:

$$116.8 = \frac{(73.5+63.9E_a)\,(1-0.624)}{1-0.624E_a}$$

or

$$E_a = 0.922$$

From this, the A for propane equals:

$$1.03 = \frac{L_a+\Sigma l_b}{K_a\Sigma v_b} = \frac{L_a+285}{(1.01)\,(578.3)}$$

which gives a new $L_a = 316$ mols/hr., compared to the 254 originally computed.

Now, for ethane:

$$E_a = A = \frac{316+285}{(2.8)\,(578.3)} = 0.372$$

requiring by Equation 15 a new E_s:

$$3.5 = \frac{(30.0+67.8\cdot 0.372)\,(1-E_s)}{1-0.372E_s}$$

or

$$E_s = 0.960$$

This value compares well with the previously calculated value of 0.955, so the $L_a = 316$ is approximately cor-

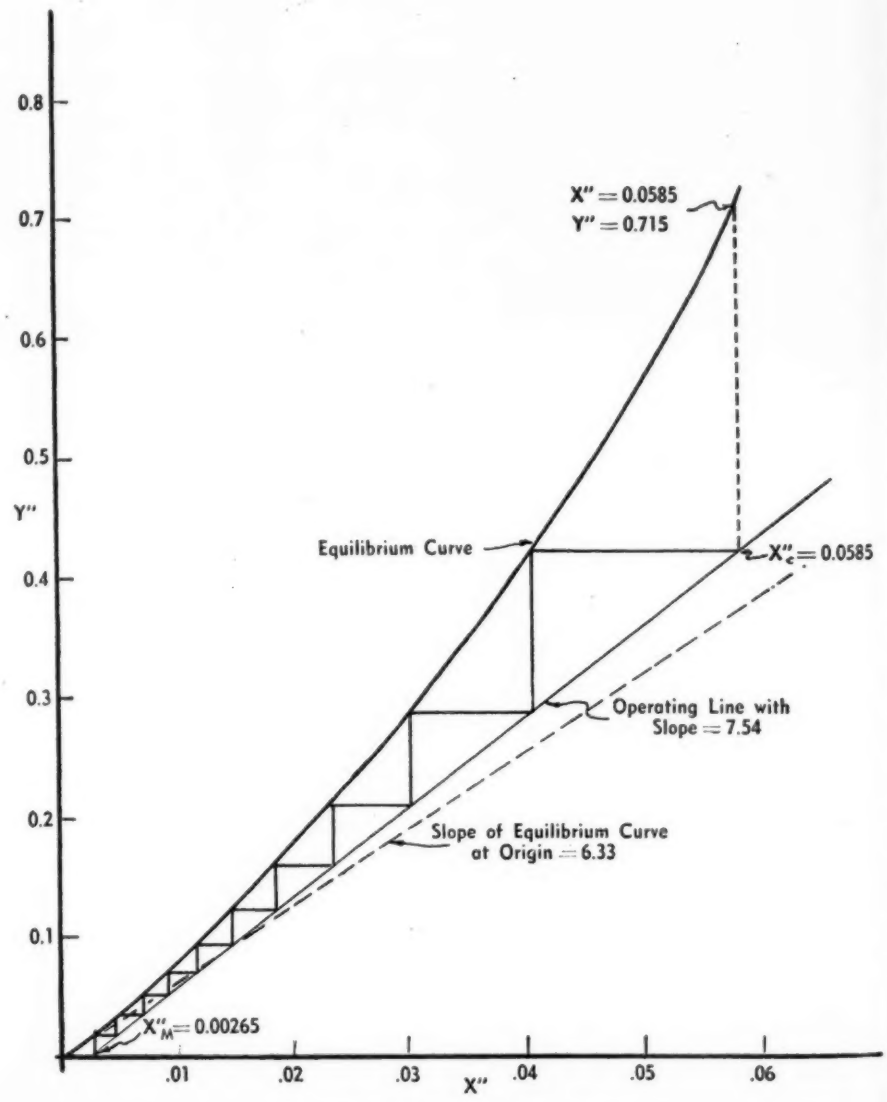
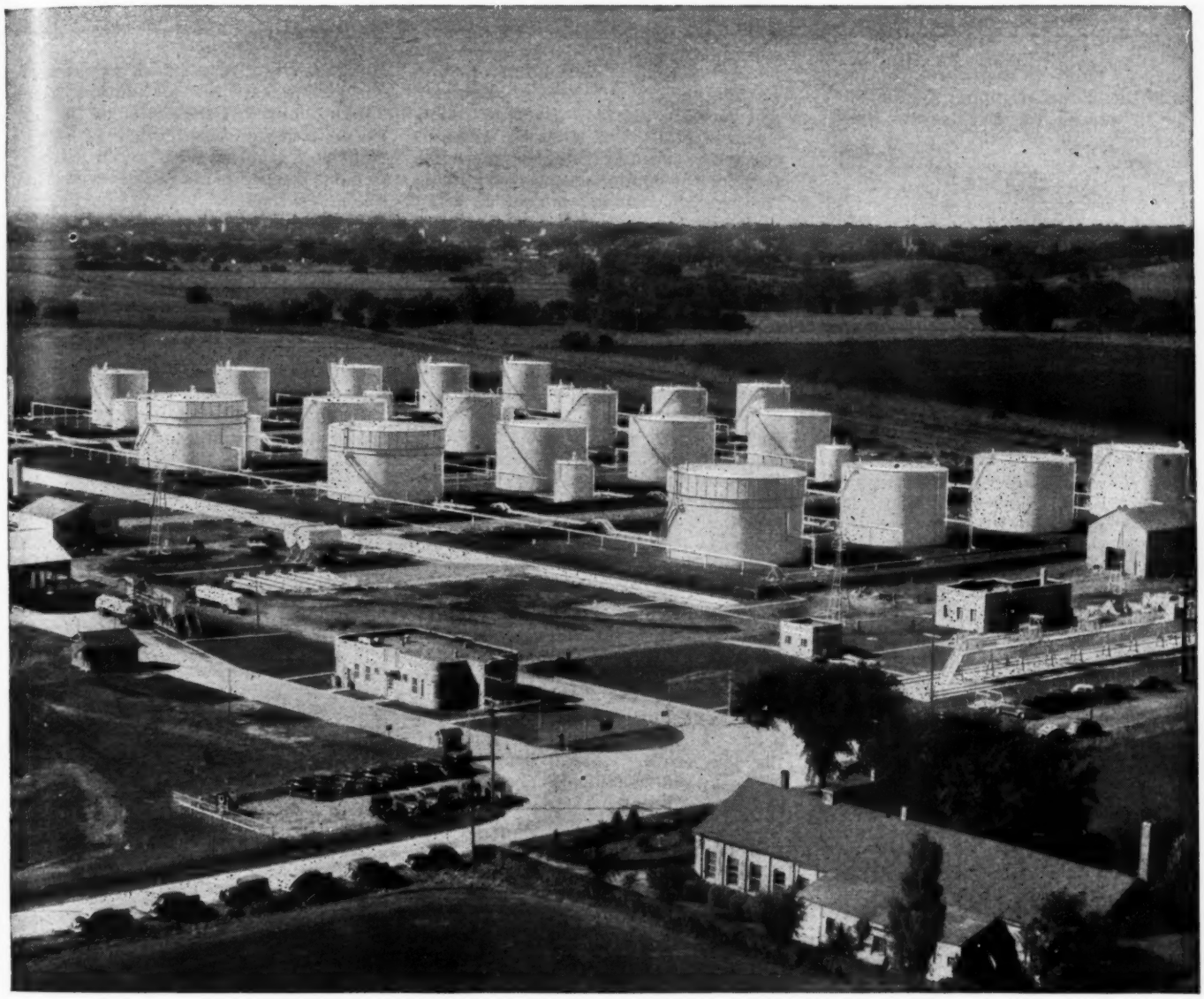


Fig. 6—Ethane stripping curve



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rect. V_s must be readjusted to maintain the same stripping factor with the increased oil circulation. Previously the oil to gas ratio at point "c" was

$$\frac{490+254+576}{236.5+175}=3.21$$

With L_s increased to 316, the ratio is

$$\frac{490+316+576}{236.5+V_s}=3.21$$

Solving this gives a V_s=194 mols/hr.

Thus, by a series of successively closer approximations which converge rapidly, we have arrived at a solution of the problem in designing a rich oil de-ethanizer. If the 50% plate efficiency is used the tower will contain 20 absorbing and 20 stripping plates for a total of 40 plates. Design of the column with respect to the liquid load should include a reasonable overload and safety factor. A figure of 25% is suggested for this to assure flexibility in operation and to cover the approximations in the method of calculation.

Thus, using a lean oil which would run 25 gals. per mol, with a safety and overload factor of 25%, the oil circulation for this column would be (316)(1.25)(25)/60=165 gpm. lean oil to the top of the column. The stripping steam demand is (194)(18) =3500 lbs./hr. at a minimum pressure of 200 psig. No safety factor is applied to the steam as the vapors from the reheater will supply this needed increment. The main function of this reheater is to prevent a serious fall-back in the temperature below the feed plate. The duty for it is calculated to supply the heat of vaporization for the components stripped from the rich oil with due allowance being made for sensible heat effects if they are of sufficient magnitude.

Condensation of Stripped Vapors

In the above problem, steam was removed from hydrocarbon vapors prior to the entry of the latter into the absorption section. This is accomplished by passing the hydrocarbon-steam mixture through a cooler (see Figs. 7 and 8, and related discussion, which follow later in this article). Some of the hydrocarbons will condense with the steam and will return to the stripping section instead of proceeding into the absorption section, an effect that was ignored in the preceding calculations.

Since this hydrocarbon condensation is less selective than the corresponding absorption condensation that would have occurred if the condensed material had remained as a vapor, some recycling of this material will occur between the two sections. If the temperature spread between the two sections is not very great (as in the above problem) this effect will be practically negligible. However, if the stripping section should run very hot, a substantial portion of the hydrocarbons to the cooler would be liquefied, and the effect would be to increase lean oil circulation above that required if the effect of the condensation were negligible.

The effect may be taken into account by performing an equilibrium condensation calculation on the vapors to the absorption section computed above. The vapor remaining after condensation is then taken to the absorption section, and the absorbed material added to the condensed hydrocarbons and the liquid portion of the feed to give total rich oil to the stripping section. This recycle calculation is continued two or three times up and down the tower until final results are obtained.

Various Stripping Media

Steam—Except for one complicating factor, steam is an ideal stripping medium. This factor is that it will condense internally upon reaching the absorption section. The resulting water may be eliminated by means of a draw-off tray located in the bottom of the absorption section and functioning in the same manner as one used in an absorption oil still. The objection to this is that the steam on condensing releases its heat of condensation to the absorption section and thus increases the temperature at the bottom of the section. (The disadvantage of such an increase will be demonstrated later in this discussion.) If there are two towers available, the problem may be solved

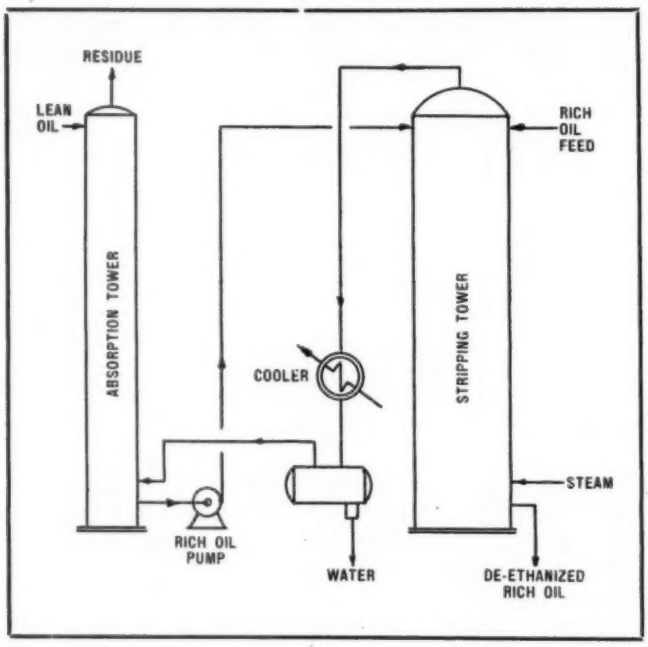

Fig. 7 (above)—Two-tower de-ethanizer

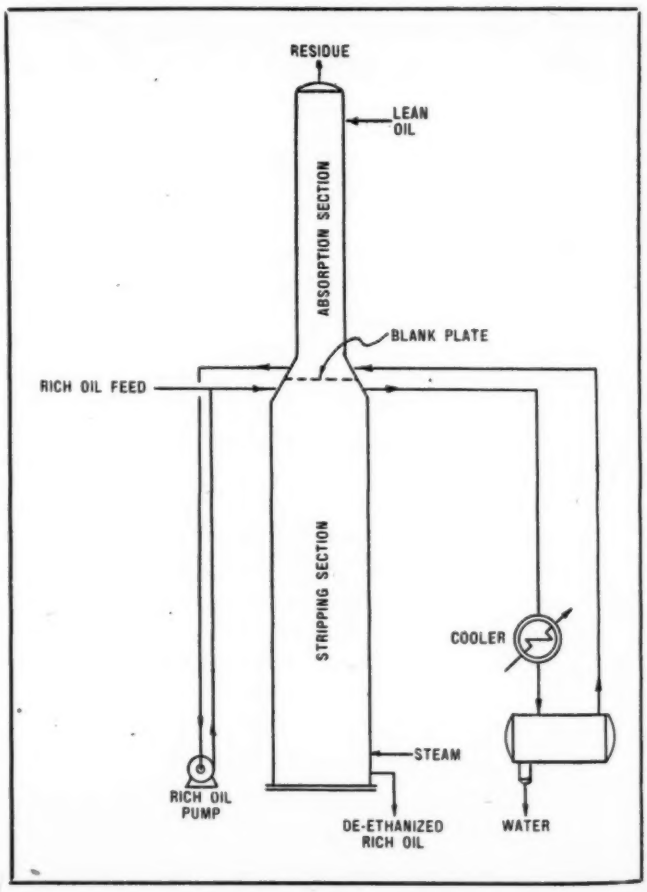

Fig. 8 (right)—Single-tower de-ethanizer

by separating the two sections and installing a rich oil pump and a vapor cooler as shown in Fig. 7. A more economical arrangement is shown in Fig. 8, wherein a blank plate is inserted between the two sections. In some installations it is possible to arrange the pressure drops so that the rich oil pump may be eliminated.

Residue Gas Containing Methane and/or Ethane—For a stripping vapor containing one or more of the lightest components, Equation 5 may be written:

$$(x_c-x_M)/(x_c-x_M^*)=f(S) \quad \ldots (5b)$$

We have defined the stripping efficiency E_s as

$$E_s=(x_c-x_M)/x_c \quad \ldots (5c)$$

We may combine this with Equation 5b to give

$$E_s=(x_c-x_M)/x_c = f(S)\cdot(1-x_M^*/x_c) \quad \ldots (18)$$

Equation 18 simply states that, when the stripping vapor contains some of the hydrocarbons being processed, the stripping efficiency is reduced by the fraction x_M^*/x_c. In the example just worked, it was seen that the stripping efficiency for methane was 1.00 and for ethane it was 0.955. This means the rich oil came into equilibrium with the stripping vapor with respect to the methane present, and also was almost completely in equilibrium with respect to the ethane. From this it follows that the presence of these components in the stripping vapor would have insured an equilibrium quantity of methane in the bottoms and an increased amount of ethane also, under the given liquid and vapor flow conditions. Therefore it is seen that the use of residue gas containing methane or ethane is not to be recommended as it defeats the basic purpose of the rich oil de-ethanizer.

Propane and/or Butane—At first glance, it might appear that a rich oil de-ethanizer recovering less than 100% propane also would lose a considerable amount of stripping vapor if the latter contained propane. Such is not the case. The explanation lies in the fact that there will be a decrease in the amount of propane stripped, a decrease equaling the amount of propane in the stripping vapor. Consequently the same amount of propane will enter the absorption section as enters when steam is used, and the same propane loss will be incurred. The following derivation should clarify this point. The same assumptions will be used as in Equations 1 through 15.

If y_{M+1} is the mol fraction of propane in the stripping vapor, then

$$x_M^* = \frac{y_{M+1}}{K_s} = \frac{v_{M+1}}{V_s K_s}$$

also

$$x_c = l_c/L_s$$

Substituting these in Equation 18 gives:

$$E_s=f(S)\,(1-v_{M+1}L_s/l_cK_sV_s) \quad (18a)$$

but for the stripping of propane, $f(S)$ approximately equals S, or

$$f(S) = K_sV_s/L_s$$

Substituting this in Equation 18a:

$$E_s=f(S)-v_{M+1}/l_c \quad \ldots (18b)$$

Proceeding by the same method that was used in deriving Equations 13 and 15, and also noting that the amount of propane at "c" has been increased by v_{M+1}:

$$v_b=v_f+v_c \quad \ldots (19)$$
$$l_c=l_f+l_b \quad \ldots (20)$$
$$l_b=E_av_b \quad \ldots (21)$$
$$v_c=E_sl_c+v_{M+1} \quad \ldots (22)$$

Solving Equations 19 through 22 simultaneously for l_c:

$$l_c=\frac{l_f+E_s(v_f+v_{M+1})}{1-E_aE_s} \quad \ldots (23)$$

Substituting Equation 18b into 23 gives:

$$l_c=\frac{l_f+E_s(v_f+v_{M+1})}{1-E_af(S)+[E_av_{M+1}/l_c]} \quad (23a)$$

Solving for l_c:

$$l_c=\frac{l_f+E_av_f}{1-E_af(S)} \quad \ldots (24)$$

Since

$$l_M=l_c(1-E_s) \quad \ldots (25)$$

Substituting Equations 18b and 24 into 25:

$$l_M=\frac{[l_f+E_av_f][1-f(S)]}{1-E_af(S)}+v_{M+1} \quad (26)$$

Equations 24 and 26 give the amount of component (propane) in the oil at "c" and in the bottoms, respectively. They are equivalent to Equations 13 and 15, except that the latter were derived for a stripping vapor containing none of the component. Note that for $E_a=1$ (100% absorption in the upper section), Equation 26 reduces to

$$l_M=l_f+v_f+v_{M+1}$$

or all the component entering the tower, including that in the stripping vapor, appears in the bottoms.

Equation 24 is identical to 13, with the substitution of $f(S)$ for E_s. Equation 26 is identical to 15, with the same substitution and the addition of v_{M+1}. Since Equations 13 and 15 were derived under assumptions that made $E_s=f(S)$, it is apparent that for a given amount of lean oil and stripping vapor, changing to a stripping medium containing propane leaves l_c unchanged and l_M merely increased by v_{M+1}, the amount of propane present in the stripping vapor. This effect may be regarded in two different ways:

(a) All the propane in the stripping vapor is condensed in the stripping section and the amount of propane stripped out of the oil is unchanged; or

(b) All the propane in the stripping vapor goes through to the absorption section, but the amount of propane stripped out of the oil is decreased by an amount just equal to the amount of propane in the stripping vapor.

From either point of view no additional propane will be lost overhead because of its presence in the stripping vapor. The same oil and stripping vapor quantities may be used to produce a given separation between ethane and propane.

Actually, the diagram corrections will change this situation slightly. The effect of using propane stripping vapor will be to increase the average liquid downflow in the stripping section. This will change the initial slope of the equilibrium curve of the ethane stripping diagram. In the construction of this diagram:

(a) X''_c (ethane) is unchanged. This follows from the fact that the l_c column of Table 3 is unchanged.

(b) $1 + \Sigma Y''_c$ is unchanged. This is because $\Sigma Y''_c=\Sigma v_c/V_s=(\Sigma l_c+\Sigma v_{M+1}-\Sigma l_M)/V_s$ where the addition of Σv_{M+1} is counteracted by a decrease in the l_M column of Table 3. V_s is practically unchanged.

(c) $K_s/\Sigma X''_M$ will decrease because $\Sigma X''_M=\Sigma l_M/(L_a+L_f+\Sigma l_c)$ and Σl_M has increased as mentioned above. $K_s/\Sigma X''_M$ is the initial slope of the equilibrium curve. Therefore a small increase in stripping vapor and lean oil circulation will be required to overcome the increased curvature of the equilibrium curve.

All the above reasoning concerning the use of a stripping medium containing propane, applies equally to the use of butane or heavier for the same purpose.

To repeat, the use of propane and/or butane as the stripping medium will result in only a small increase in the required stripping vapor and lean oil.

It is advantageous that the stripping vapor will, in effect, condense in the stripping section. This action releases a considerable amount of heat, a fact that may make any reheater unnecessary. Furthermore, unlike the case of steam stripping, no water removal arrangement will be needed. The use of propane and/or butane has the great disadvantage, however, of producing a big recycle stream; the stripping medium must

About the Authors

Charles F. Sanderson and Alan F. Glendening recently formed a consulting engineering partnership specializing in the light hydrocarbon and organic chemicals industries.

Mr. Sanderson, now completing doctorate requirements under a Gulf Oil Co. graduate fellowship in chemical engineering at Texas A & M College, has had six years industrial experience, with Celanese Corp., Lummus Co., and Petroleum Engineering, Inc. He also assisted in economic process evaluation of government-owned synthetic rubber and "avgas" plants while a candidate for the master's degree at A & M, and is a registered engineer of Texas.

Mr. Glendening was born in Paris, but came to this country two years later. He was graduated from Princeton as an electrical engineer in 1944, and went with Petroleum Engineering, Inc. the following year as a process engineer, which company he has left to become junior partner in the Sanderson-Glendening firm.

be recycled through the still, gasoline condensers, depropanizer and, if butane is used, through the debutanizer. Since the stripping vapor may exceed the production of propane and butane it is obvious that their use as a stripping medium will substantially enlarge all the equipment mentioned above as well as the utilities connected thereto.

Stripping with Rich Oil Vapors—This may be accomplished by installing a large reheater at the base of the tower, or by recycling hot rich oil vapors produced by passing the rich oil bottoms through a furnace. Such vapors, although containing a small amount of ethane, will consist mainly of propane, butanes, and pentanes. The discussion of propane and butane stripping vapor in the immediately preceding section applies equally to components heavier than butane. Consequently, the calculation procedure outlined in that section applies also to stripping with rich oil vapors.

Tower Operation

The question arises as to what type of temperature distribution is most desirable: whether it is best to have a smooth semi-continuous gradient from top to bottom or whether the gradient should be sharply discontinuous at the feed plate with the stripping section as hot and the absorption section as cold as possible. This may be settled as follows:

For any component $A=L_a/K_a\Sigma v_b$ and $S=K_aV_a/(L_a+L_f)$. Assuming that total vapors are constant within each section and differ by a constant amount, C, then $V_a=\Sigma v_b-C$. Substituting this in the second expression above, solving both expressions for Σv_b, and equating:

$$L_a/K_aA=[S(L_a+L_f)/K_a]+C$$

and solving for L_a:

$$L_a=SL_f+K_aC)/[(K_a/K_aA)-S] \quad (27)$$

Similarly, using the same basic equations but this time eliminating L_a and solving for V_a:

$$V_a=(L_f+K_aAC)/[(K_a/S)-K_aA] \quad (28)$$

Over a moderate range of temperatures the relative volatility of ethane to propane remains approximately constant. Assuming constant relative volatility and a given number of plates, values of A and S for ethane and propane are fixed by the amount of each that appears in the bottoms. Thus, for a given system, L_f, A, S and C are all approximately constant. Since K increases with increasing temperature, Equation 27 shows that for a given bottom section temperature, lean oil to the top section may be lowered by decreasing the average top section temperature.

Similarly, Equation 28 shows that for a given top section temperature, stripping vapor may be lowered by increasing the average bottom section temperature. From the preceding it follows that maximum economy of lean oil and stripping vapor will be realized by keeping the entire top section as cold as possible and the entire bottom section as hot as possible.

Controls

Ideally the rich oil de-ethanizer should be automatically controlled with respect to propane inclusion in the residue gas and ethane inclusion in the bottoms. Such control conceivably could be accomplished by simultaneous adjustment of the stripping vapor and lean oil circulation. However, if there is a method available to accomplish this, the authors are not familiar with it.

Controlling propane in the residue could be done only by controlling the gravity of the residue. Since the propane content of the latter is low, close control based on variations in gravity is not possible.

Ethane in the bottoms might conceivably be controlled by a temperature bulb at the bottom throttling the stripping vapor. However, the mol fraction of ethane in the bottoms is extremely low, and once again close control is not possible. An alternative might be to control stripping vapor from the vapor pressure of the propane product at the depropanizer. This method, however, would result in a large time lag in operation with consequent over-control of process vapor.

Apparently therefore, there is no satisfactory way of automatically controlling the unit for maximum propane retention. It is suggested that lean oil, stripping vapor, and steam to the reheater be run on flow controllers, and with manual adjustments according to the vapor pressure of the propane product and analyses of the residue gas.

Nomenclature

The symbols and nomenclature below have been used in deriving design formulae and graphical solutions throughout this and installments of the series to follow.

A = Absorption factor (L/KV).
E = Fraction of component absorbed or stripped from an entering stream.
K = Equilibrium Constant (y/x).
L = Mols per hour of liquid at any point.
M = Total number of theoretical trays in the stripping section.
N = Total number of theoretical trays in the absorption section.
S = Stripping factor (KV/L).
V = Mols per hour of vapor at any point.
X = Molal ratio: mols of component per mol of lean oil.
Y = Molal ratio: mols of component per mol of entering gas.
l = Mols per hour of component in the liquid phase.
v = Mols per hour of component in the vapor phase.
x = Mol fraction of component in the liquid phase.
y = Mol fraction of component in the vapor phase.

Superscripts

* = Denotes the equilibrium state.
$'$ = Refers to the absorption section.
$''$ = Refers to the stripping section.

Subscripts

a = Refers to the absorption section.
b = Refers to the point just below the bottom plate in the absorption section.
c = Refers to the point just above the top plate in the stripping section.
f = Refers to feed.
M = Refers to the stream leaving the bottom plate in the stripping section.
m = Refers to any plate in the stripping section.
n = Refers to any plate in the absorption section.
s = Refers to the stripping section.
1 = Refers to the top plate in the absorption section.

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Compression Ratios Move Up

By PAUL WOLLSTADT, News Editor
Petroleum Processing

Car manufacturers, General Motors at least, can build engines with increasingly higher compression ratios without major retooling of their plants. Five years from now production cars may need 100-octane gasoline—if the oil companies can supply it.

These and other significant facts relative to future motor fuel requirements are pointed out in the accompanying article which appeared first in the Jan. 26th issue of National Petroleum News. It is republished here because of the importance of the developments reported to refining technologists.—Editor

THE world's largest manufacturer of automobiles has committed itself to a program of building passenger car engines that will require fuels of increasingly higher octane rating.

As concerns the oil industry, the most significant postwar automotive development is that General Motors can build an engine with an 8 to 1, a 10 to 1 or even a 12 to 1 compression ratio *without a major retooling.* This engine, which is in the 1949 Oldsmobile Eight with a 7.25 to 1 compression ratio, was designed from scratch — something an automobile manufacturer can afford to do only every 10 to 20 years. A similar engine is in the Cadillac with a 7.50 to 1 compression ratio. Both of the 1949 models are satisfied with most present premium gasolines, but these engines are just the beginning.

Even five years from now, cars may be coming off the production lines with engines that will need a fuel of 100 octane (Research), *National Petroleum News* was told by Charles L. McCuen, General Motors vice president in charge of the Research Laboratories Division, during GM's first postwar transportation show which opened at the Waldorf-Astoria in New York last week.

After reluctantly making the "100 octane in 1954" guess, Mr. McCuen emphasized that he was not seeking to write a timetable. It all depends, he says, upon when the gasoline is in the service stations on a nationwide basis. GM, he indicated, will be ready to boost the compression ratio and the octane number demand with any model year change.

Two 'Trial Balloons'

The new engines are now only in the Oldsmobile Eight and the Cadillac, but James M. Crawford, GM's engineering vice president, suggested that the company is putting its future chips on higher compression for the other cars also. Asked when GM would have the new engine in the Chevrolet, Pontiac and Buick, he replied:

"These new engines (Oldsmobile and Cadillac) are two trial balloons to give the petroleum industry assurance that we mean business when we talk about high compression."

Engine developments that will create and expand a market for steadily higher octane fuels are getting attention from all the auto manufacturers. At the moment, however, the GM developments stand out in significance for the oil industry because its program seems almost certain—barring a war—to push all premium grade octane numbers higher or compel the marketing of a new "super-premium" as a third grade of gasoline.

General Motors recognizes that a change to higher octanes is not merely a matter of turning a valve in a refinery. It also knows that a higher compression engine isn't worth the steel it is made of unless the fuels required are available in every part of the United States.

Evolution, Not Revolution

In their public talks as well as private conversations during the New York show, GM President C. E. Wilson, Research Director McCuen and Engineering Director Crawford said, in effect, that the complexities of the oil industry make it necessary to move to general distribution of higher octane gasoline through evolution, not revolution.

Probably a fair summary of the attitude of these men is this: We can't put an engine on the production line until gasoline for it is available to virtually every potential customer. The faster octane numbers go up on a national basis, the better we'll like it, provided that the increase in quality is not at the expense of an adequate supply of gasoline for the older cars. We're not in the oil business, so we don't understand all of the problems of refining and distribution. But we're counting on competitive forces in the oil industry to make higher octane premium fuels available nationwide, either through a three-grade gasoline distribution system or by gradual improvement of premium in two-grade distribution.

A Better Understanding

There has been considerable improvement in oil-auto understanding on this problem during the past year. General Motors originally planned to put an 8 to 1 compression ratio engine, requiring gasoline of 93 Research rating, into the 1949 Oldsmobile and Cadillac. GM so told a group of oil men in Detroit in the fall of 1947. (See NPN Oct. 29, 1947, page 11.)

The oil industry then was in the midst of a product shortage, and an increase in quality would mean a decrease in quantity. The lead shortage then was near its peak. Several of the oil men at the meeting told General Motors that widespread distribution of 93 octane gasoline was impossible at that time. A survey made by *National Petroleum News* showed that most oil industry leaders shared this view.

General Motors engineers subsequently made what they describe as an adjustment in the design, consisting primarily of changing the piston displacement, so that the new engine would operate on current premium gasolines, with a minimum of 86 (Research) rating, but preferably higher

Other Ways to Do It

There are still a number of people in the oil industry who believe that there are better answers than high compression to the fuel economy problem, such as supplementary injection, a dual fuel system and completely automatic transmissions. A few have suggested that the higher costs of manufacture and distribution might erase the dollar and cents advantage for the consumer if octane numbers were moved up too rapidly.

On this point, GM President Wilson says: "If it isn't an economic thing for the customer, it will never be a go. In other words, it (higher octane gasoline) has to be able to deliver a better result for the customer, or it isn't worth while." GM obviously thinks that the road it wants to take of higher compression ratios and higher octane numbers will be worth

while or it wouldn't have designed a new engine the way it did.

In the meantime Mr. McCuen, as research director, indicates that his men are continually on the hunt for what he calls "mechanical octane numbers," several of which he said were built into the new engine. He defines a "mechanical octane number" as an engine design feature which will decrease the octane requirement without loss of performance or economy.

According to reports reaching GM, owners of the new Oldsmobile Eights and Cadillacs are getting satisfactory performance with most present premium gasolines. Of the few complaints from owners, most have come from the Midwest. (The recent octane survey by the Bureau of Mines shows that average ratings on premium are lower in the Midwest than on the coasts—see NPN Jan. 12, page 20.)

Gasoline and Cars Vary

Such complaints, however, are not considered unusual by either the oil or automobile industries. Not only is there variation of gasoline quality, but there is often considerable variation in the octane requirements of the same models of automobiles. Two cars of the same make and model may vary as much as 25 numbers in their octane requirements after a few thousand miles of driving.

Common sense co-operation among the owner, the automobile dealer and the gasoline station may save considerable misunderstanding regarding the fueling of any car, but especially the new Oldsmobile and Cadillac because they are "designed to the hilt of present fuel availability," as one oil company automotive engineer put it. Inadequate performance may not be at all the fault of fuel quality, but of something the car dealer or other competent mechanic can fix.

Compression Ratio Average Up

While making the automobile buyer more conscious of gasoline quality, the new engine is making both the oil and the automotive industries more conscious of compression ratios. While compression ratios are generally indicative of the demand for quality in fuels, they are not the only factors affecting octane requirement or efficient use of gasoline. For example, the optional head on the Pontiac gives it a 7.50 to 1 compression ratio, but it is not claimed to be as efficient an engine as the Oldsmobile at 7.25 to 1.

Table 1, this page, lists the 1948 and 1949 compression ratios of all passenger cars. The 1949 average compression ratio of 6.87 to 1 is the highest ever. This figure has climbed steadily since 1925, when it was 4.4, except for one decrease from 1938 to 1939.

TABLE 1—Compression Ratio Comparison

Make and Model	1948	1949
Buick 70—Dynaflow	6.90	6.90
Buick 50—Dynaflow	...	6.90
Buick 50	6.60	6.60
Cadillac (All Models)	7.25	7.50
Chrysler (Six)	6.60	7.00
Chrysler (Eight)	6.70	7.20
Chevrolet	6.50	6.60
De Soto	6.60	7.00
Dodge	6.70	7.00
Ford (Six)	6.80	6.80
Ford (V-Eight)	6.75	6.80
Hudson (Six)	6.50	6.50**
Hudson (Eight)	6.50	6.50**
Kaiser	7.30	7.30
Frazer	7.30	7.30
Lincoln	7.20	7.00
Mercury	6.75	6.80
Oldsmobile (Six)	6.50	6.50
Oldsmobile (Eight)	7.00	7.25
Nash—600	7.00	7.00***
Nash—Ambassador	7.02	7.00***
Packard (All Models)	7.00	7.00
Pontiac (Six)	6.50	6.50***
Pontiac (Eight)	6.50	6.50***
Plymouth	6.60	7.00
Studebaker—Champion	6.50	6.50**
Studebaker—Commander	6.50	6.50**
Willys (Four)	6.48	6.48**
Willys (Six)	6.42	6.42**
Average Compression Ratio*.	6.73	6.87

* Averages are weighted in accordance with number of models listed by the manufacturers. In 1948, 57 models were listed. A preliminary check indicates 54 models will be listed for 1949.

** Optional head with 7.00 to 1

*** Optional head with 7.50 to 1

General Motors engineers believe, according to W. J. Davidson, executive engineer, that "performance is approaching its limit. By performance we mean acceleration, high climb, top speed, etc. We, therefore, feel that in raising compression from here on out the gain will be taken out mainly in economy."

GM's Fuel Saving Estimate

Following are figures in a chart that was displayed at the General Motors exhibit in New York, to show its estimates of fuel savings with higher compression ratios:

Compression ratio	Percent Gain in Economy	Octane* Requirement
6.50 to 1	0	80
8.00 to 1	10 to 20	93
10.00 to 1	25 to 35	98
12.00 to 1	30 to 35	100 plus

* The chart did not indicate whether ASTM or Research method, but Research is obviously meant.

"A high compression program," said Executive Engineer Davidson, "must be a joint one between the automotive industry and our gasoline producers because, of course, they are interdependent."

Will the Public Understand?

While the automobile people are realizing the problems connected with manufacture and distribution of increasingly higher octane fuels, there is some doubt that the public does.

It is not widely known outside the industries directly concerned that there is a greater difference between 90 and 91 octane than between 70 and 72; that the difference between 99 and 100 is about the same as the difference between 70 and 73.5. (W. M. Holaday, director of Socony-Vacuum's laboratories, gave an outstanding paper on the refiner's problems in raising octane numbers at the SAE meeting in Detroit a year ago—see NPN Jan. 14, 1948, page 41. Among other things Mr. Holaday pointed out that about 20% of straight-run gasoline would be lost by a refiner in hydroforming and other chemical manufacturing processes to make large volumes of 89/99 octane gasoline and that operating expense would be very high.)

The public does not realize either that there is an immense difference in distribution costs between supplying relatively few civilian and military airports with aviation gasoline and putting a third grade of "superpremium" automobile gasoline into thousands upon thousands of service stations.

The Question of Cost and Price

President Wilson of GM told a large group of newspapermen in New York last week that higher octane gasoline will involve "some more cost" and that "for a time there may be some more cost in distribution." Then he added: "Naturally the people in the petroleum industry will expect to cover their cost and make a profit." (Incidentally, Mr. Wilson expressed his views on the profits of his company in connection with another question when he coined this phrase: "We really want to earn a profit, not just collect a toll.")

Price may have a big influence on the octane trend. If premium grade octane moves up and housebrand octane stays about where it is, it is likely that the price spreads between premium and housebrand would widen. This probably would result in a decrease in the percentage of premium to housebrand sold at gasoline stations.

Probably the principal key to what happens on octanes will be the overall gasoline supply situation. An influence on the side of higher octanes is the increase in refining capacity (see front cover NPN Jan. 19). Another is the flattening of the upward curve of demand. A third is the continued gradual easing of the tetraethyl lead supply.

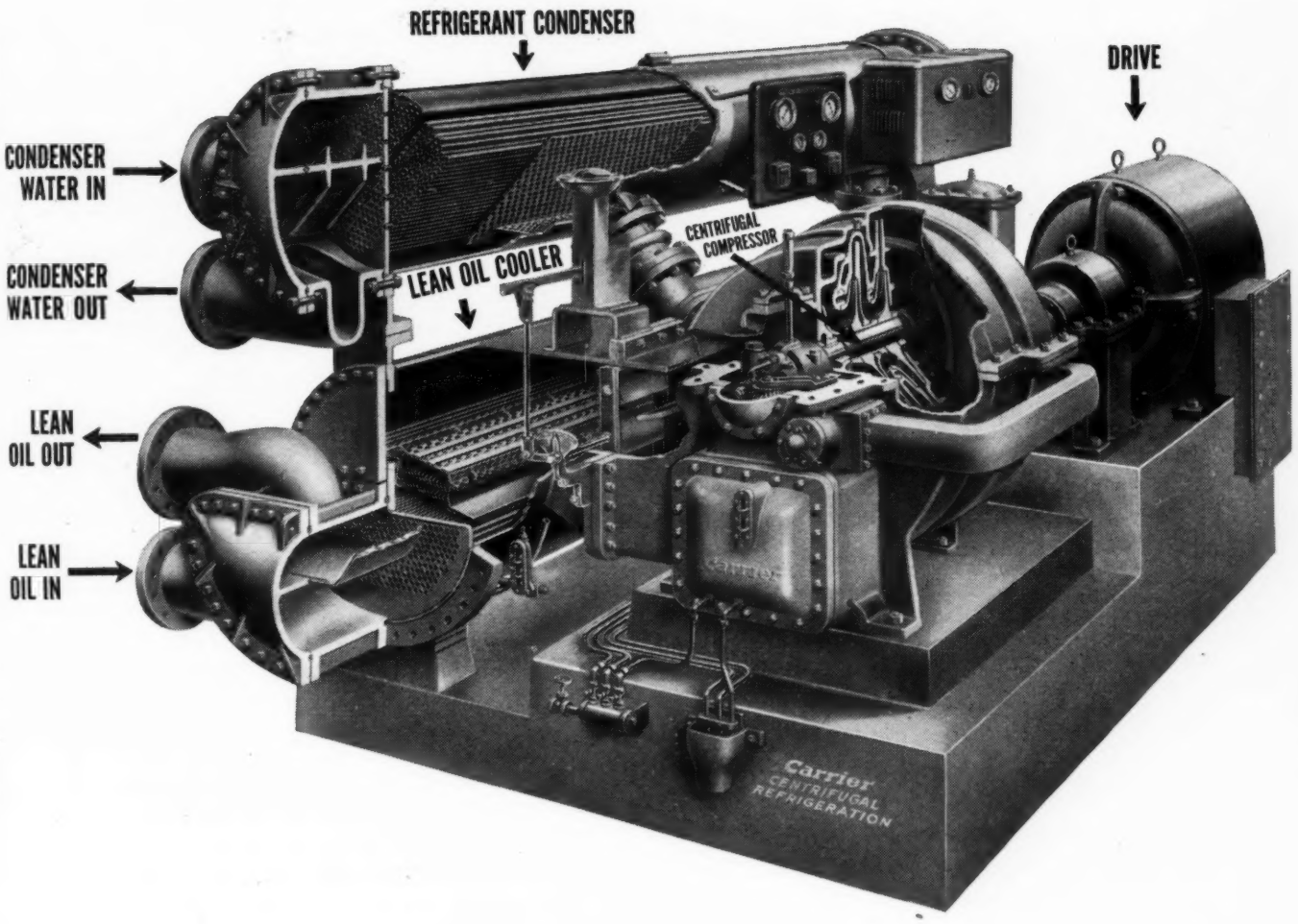
Among the possibilities which may keep octane numbers down are:

1. Further development of and consumer acceptance of such things as supplementary injection or dual fuel systems.
2. Development of additional "mechanical octane numbers" by automotive engineers.
3. Discovery of some new idea to permit presently available grades of gasoline to satisfy higher compression engines.

PROBLEM:

Higher butane and propane recovery

SOLUTION:



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Cleanliness in all Exchangers Essential To Maintain High Heat Transfer Rates

By D. P. THORNTON, Jr., Southwestern Editor

CLEANING of individually fouled heat exchange equipment will not bring the desired increase in efficiency if other equipment is dirty, natural gasoline plant operators were told at the second annual Panhandle-Plains meeting of the Natural Gasoline Association of America in Amarillo, Texas, December 10.

Plant operating matters in general, with emphasis on the practical side, provided the theme for this meeting. More than 350 men packed the two sessions, setting a new attendance record for NGAA regional meetings. Topics discussed included:

Methods for cleaning heat exchange equipment.

Dehydrating natural gas with adsorbents.

Operating fractionators for sharp separation.

Field remedies for common meter difficulties.

Increasing gas compressor pumping capacity with piston clearance pockets.

Workable safety programs for gasoline plants.

The comments on heat transfer efficiency were presented in a most practical paper, "Discussion of Methods for Cleaning Heat Exchangers," by J. S. Connors and L. J. Weber, Phillips Petroleum Co., which described chemical and mechanical cleaning methods, first emphasizing the importance of keeping all exchange equipment clean. The effect of water-side deposits, while admittedly great, often distracts operators' attention from the loss of heat transfer efficiency at other locations. On this point the authors cited the following example.

In a steam preheater handling 675,000 gals./day of a rich absorption oil from 310 to 365° F., a theoretical heat transfer rate of 359 Btu/sq. ft./hr./°F. could be obtained if surfaces were mirror-smooth. When commercial fouling factors are applied, the rate drops to 177 Btu. If this factor is doubled, representing deposition of organic matter on the oil side and corrosion on the steam side, the rate decreases to 128 Btu/sq. ft./Hr./°F. Similar calculations can be made for the hot and cold bank heat exchangers.

From this it is apparent that, even though oil coolers might be clean, it may be impossible to maintain low lean oil temperatures if the other heat transfer equipment is dirty. On top of this it is impossble to evaluate correctly the effect of scale on heat transfer rates.

A thin, loose or porous scale may be far more detrimental than a much thicker but hard, dense scale. Loose deposits formed by silt and mud, soot, powdered coke, vegetable matter, polymers, and slimes are the most detrimental to heat transfer. Before attempting chemical cleaning, laboratory determination of the best method, coupled with inspection of a sample after mechanical cleaning, will pay dividends, it was pointed out.

Chemical Cleaning Methods

Calcium and magnesium carbonate scales may be successfully removed with inhibited 4-7% hydrochloric acid solutions unless the amount of scale is large with respect to equipment. Silica inclusions demand use of such intensifiers as hydrofluoric acid; these usually are hazardous to personnel and equipment. The surface is immersed and solution circulated, or else sprayed, temperature being increased to a maximum of 160° F. as acid strength decreases. Treatment continues until acid strength becomes constant. The surface is subsequently water washed and should be flushed with a dilute alkaline solution if not to be returned immediately to service.

When these carbonate scales are cemented with their sulfates, or when a true sulfate scale exists, two-stage cleaning with alkali and acid is used. Sulfates are dissolved with a 5-7% sodium carbonate solution at 212° F. or higher, treatment continuing until the sulfate content becomes constant and then is followed by washing with high velocity water streams. If tubes are not plugged with sludge, the acid treatment described above follows. When scale is oil soaked, a good detergent is used with the initial alkaline wash.

Some organic scales, with or without dirt, may be removed by treating with selected solvents, the selection depending on the organic material. Another common method is by burning it. Sometimes brittle scale may be removed by thermal shock; i.e., alternately steaming and washing with high velocity water streams. Steam cleaning usually follows solvent treating.

Mechanical Cleaning

One of the best mechanical cleaning methods, it was stated, involves use of a steam or water lance pushed through the tubes. Driving pipes or rods through tubes may damage them, or merely compact the scale. Hard scale may be removed by mounting a spiral drill or wire brush on the end of the lance. External cleaning usually is a question of accessibility, hammers, coarse files, wood saws, and high velocity water streams being used. Sandblasting must be used cautiously and is possible only where sufficient space exists between adjacent tubes to permit inserting the nozzle. Thermal shock often may be used without dismantling equipment when one side of the tube is normally hotter than the other, by intermittently interrupting the flow of either fluid.

Burning must be done carefully, the tubes being cooled internally with steam while applying the torch externally. Some companies use furnaces accommodating the entire bundle to oxidize fouling substances under controlled conditions. Subsequent tube re-rolling usually is necessary to prevent leaks, the Phillips Petroleum Co. paper brought out.

Drying Natural Gas

E. G. Hammerschmidt, Texoma Natural Gas Co., discussed "Dehumidification of Natural Gas by Adsorption," based on data from the company's dehydrating plants at Fritch and Stinnett, Texas, handling respectively 80 and 230 million cu. ft. of natural gas daily. Commercial adsorbents used include 'Florite' and 'Dri-

Gas Compressor Pistons

An important development in the design of gas compressor pistons, described at the NGAA Amarillo meeting in the paper, "Increasing Gas Pumping Capacity Through Use of Compressor Cylinder Pockets," by W. R. Barrett, Phillips Petroleum Co., was reported in the article on page 37 of the January PETROLEUM PROCESSING.

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This automobile merely illustrates the completeness of the Powell Line. The important point is that, no matter what *your* product may be, there are Powell Valves especially adapted for each and every one of your flow control services.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", inclusive. Has outside screw rising stem, bolted flanged yoke and tapered solid wedge. Also available in All Iron for process lines.

Fig. 3061—Class 300-pound Cast Steel Swing Check Valve with bolted cap and flanged ends. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

Fig. 3003—Class 300-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem, tapered solid wedge.

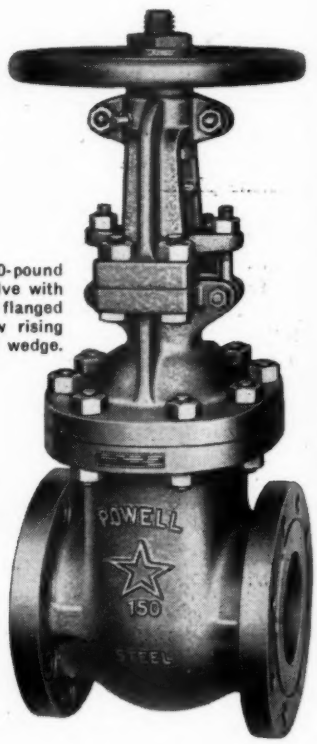

Fig. 1503—Class 150-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem, tapered solid wedge.

The Wm. Powell Co., Cincinnati 22, Ohio

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POWELL VALVES

ocel,' both activated bauxites, and 'S/V Sovabeads'. The drying towers studied each contain from 15 to 20,000 lbs of desiccant.

Tests indicated service lives of the two bauxites averaged 2.5 years per charge. Tests on single trays indicated the greatest decline in adsorptive capacity occurred in the top tray, which is the bed inlet during adsorption and outlet during reactivation. The reason advanced is that this tray gets the most "steaming" during desorption and collects the most moisture during adsorption. Graphical analysis of data indicates that approximately 9 month (30%) longer service might be obtained if the flows were reversed at the end of 2.5 years, since material on the bottom tray shows the least decline in adsorptive capacity and the last tray in effect is a scavenger.

Low Temperature Regeneration

While pointing out that the mechanism causing decline in adsorptive capacity with repeated cycles of use and reactivation has not been satisfactorily explained, the effect of heat and moisture, already mentioned, is stated to be an important factor. Experiments with mineral seal and compressor lubricating oils indicate the latter is particularly damaging to the desiccant; both are apt to be present in the gas inlet stream.

Desorption temperatures of 245° F. were said to be sufficient for reasonable reactivation although slightly better reactivation was obtained at 365° F. One objection to the lower temperature was the longer reactivation time, with the possibility advanced of generally reactivating at 300° F. and periodically going to the higher temperature.

Tests with Sovabeads, protected from slugs of entrained moisture by a layer of Florite, gave an initial water adsorption capacity for the 50-50 mixture of 15.5 wt. % (new Florite capacity is approximately 8 wt. %). At the end of one year the mixture had a capacity of 6.4; Florite alone, 5.6 wt. %. Tests also were run to prove Florite and Sovabeads will adsorb small amounts of natural gasoline which may be present in the gas. A portion of this, adsorbed at the beginning of the run, is vaporized and returned to the gas stream during the latter part of the run.

Practical Fractionation

In his paper on "Practical Fractionation," F. C. Fowler, University of Oklahoma, pointed out that in an existing fractionator the only variables which can be changed are column pressure, reflux ratio, feed location, feed temperature and fractionation sequence in multicomponent mixtures.

Column pressure affects sharpness of separation by changing the relative volatility of components. The paper suggested operating at the lowest possible pressure, pointing out that, if capacity is limited by condenser area, higher pressure will increase the available condenser temperature difference and raise the apparent capacity. If overloaded by vapor, increasing pressure will boost column capacity. Since a total overhead condenser operates at a higher pressure than the partial condenser, which condenses only reflux, the partial condenser offers a way to fractionate a product having a higher pressure than can be handled with a total condenser.

Among points discussed on reflux ratio, it was brought out that where low vapor loads are encountered, increasing reflux may give satisfactory operation. Also, reflux should be preferably at its boiling point to reduce heat load on the column and required condenser area. However, where vapor binding of the reflux pump is a problem, lowering reflux temperature without changing reflux volume is often helpful.

Feed Inlet Location

Proper feed inlet location is difficult to determine practically. Theoretically it is that point at which tray fluid composition is the same as the feed, and pressure and temperature are equal. In general if the overhead product must be of high purity and feed is low in this component, feed entry should be relatively low in the tower and vice-versa. Theoretically feed should be at its boiling point; usually it is less for control purposes with the additional heat supplied by the reboiler.

Tower capacity may be increased by supplying feed at the bubble temperature and lowering reboiler duty. Only in cases where the bottom section of the tower is overloaded by vapor is it the best practice to superheat the feed. Where columns are operated in series and subsequent columns are seemingly overloaded from flashing on the feed tray, precooling the feed may substantially increase capacity.

Definite advantages of increased production or decreased operating costs may be secured by utilizing the best possible flow sequence for each component of multicomponent mixtures, such as in natural gasoline plants. The normal sequence is in descending order of operating pressures. However, feed composition is the most important variable in determining proper sequence and the only practical method of selecting the best system is to make the appropriate process calculations.

Meter Problems

Common meter difficulties and field remedies were discussed by C. C. Clover, Westcott & Greis, Inc., from the operator's standpoint. A sudden change in an orifice meter reading when no noticeable change in flow has occurred first calls for "zeroing" the meter. If it fails to zero; the manometer chambers may be unbalanced with fluid, the orifice may be dirty, and plugged, or there may be a piping leak. Liquid may "dam up" against the orifice plate, particularly with steam meters located in a horizontal run; in the latter case it is best to use a vertical run or provide means for bleeding the water from the upstream side of the orifice plate.

Pulsation must be eliminated; with this condition measurements may be as much as 1000% too high (generally), or too low. It is best to eliminate pulsation by moving the meter away from the source, if possible, by inserting a damping resistance between orifice and source of pulsation, or by using commercial dampening devices.

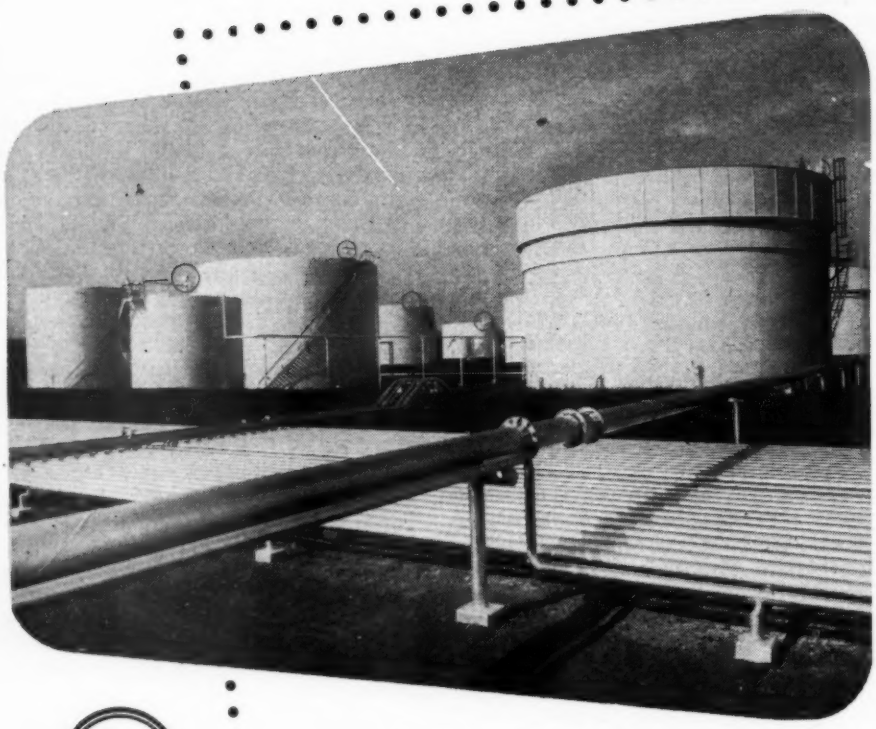
Always avoid seals on orifice meters whenever possible, it was suggested. Where they must be used, they should be of ample size, properly constructed, and located according to recommended methods. Gate or plug valves are preferable to needle valves in by-pass piping. Arrangements in which air or gas could be trapped should be avoided.

An orifice meter generally will read low if the flowing stream is rotating as it goes through the orifice plate; regulators and partially opened gate and plug valves as well as a full piping swing upstream of the orifice are frequent causes of rotating streams, or they may produce eddies which cause artificially high differentials. Forty diameters of straight pipe upstream of the orifice tap and at least five diameters from the downstream tap are recommended. Longer runs likely will add to the performance of the meter, it was stated.

Displacement Meters

Displacement type gas meters are troublesome where used on wet gas; they are excellent "drips." Gasoline will shrink the diaphragms, give fast readings; dirt and pipe scale wear the parts, produce "slow" readings; water and gum on the valves also cause low readings. Displacement type liquid meters are subject to dirt and gum difficulties also, will register high if the liquid being measured partially vaporizes. They should always be flooded and properly bled if air or gas enters the line. Differential valves often are the solution to vaporization in the meter when measuring light hydrocarbons, or downstream valves may be partly closed to create higher backpressure on the meter.

Results from a study of the safety



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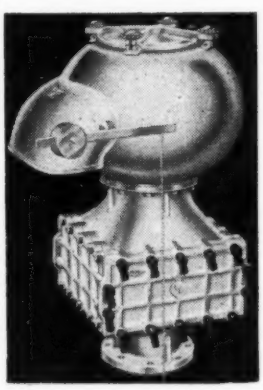

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programs of five natural gasoline manufacturers were presented by C. L. Ritter, Continental Oil Co., bringing out that these companies, with extensive safety programs had frequency and severity rates far below that of the natural gasoline industry as a whole.

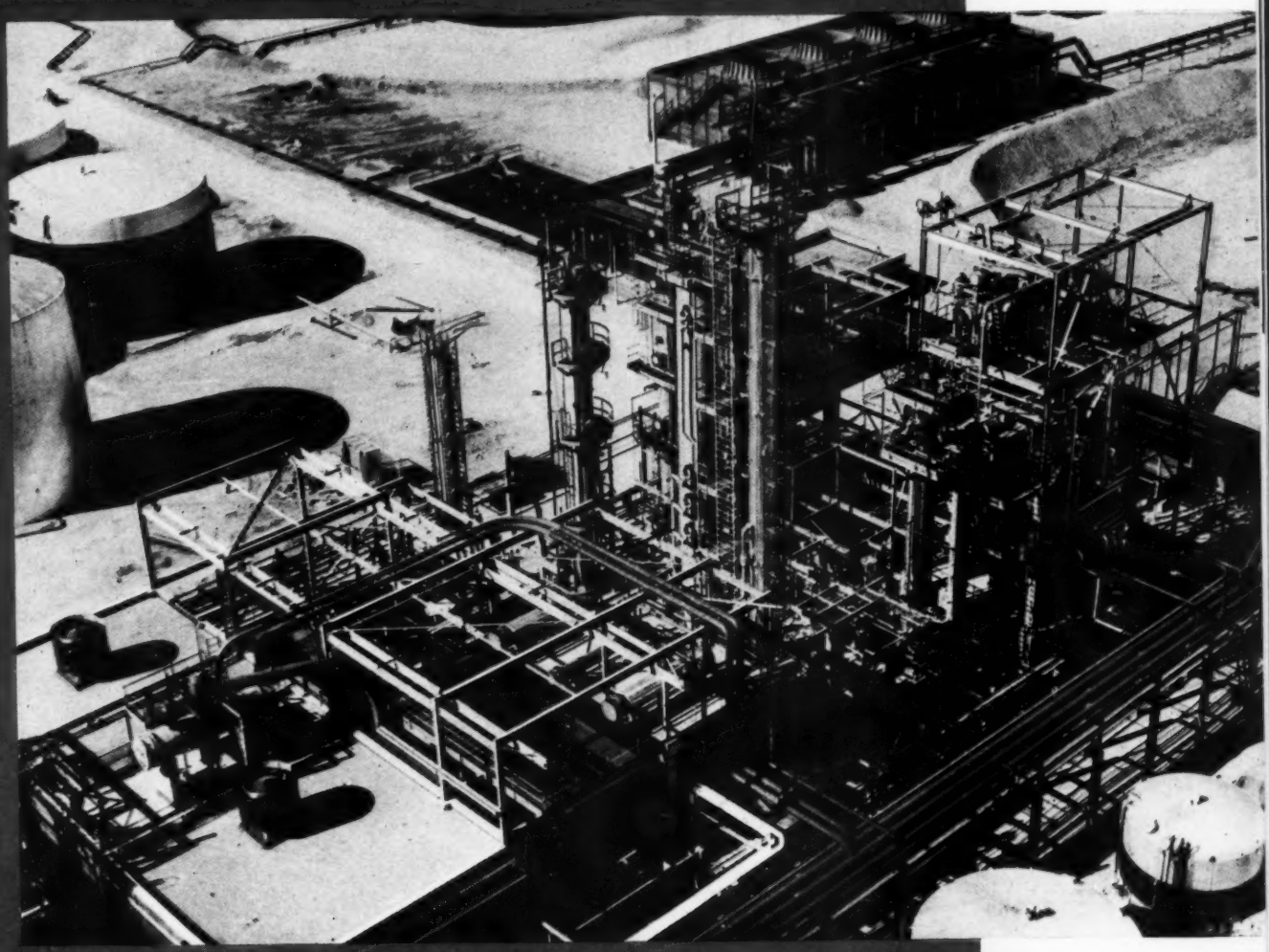
Management Co-operation

The safety rules for all participating companies were pooled and the duplications eliminated in preparing the report, salient facts from which were presented at the meeting. Each company holds regular safety meetings, several use safety inspection committees and all stress fire protection thoroughly. Automatic and emergency shutdown equipment has been installed and employees familiarized with them. First aid is stressed and each employee has the responsibility of reporting anything he deems unsafe to his supervisor or of handling it himself in an emergency. One company has told its personnel that if, in the opinion of the operator the situation is an emergency, the rule should be to shut down the plant and then decide if it really was an emergency.

The report stresses that while it is true that plant equipment and the plant area must be safe, and men must be trained to perform their jobs under adequate safety rules, all this is not enough. Men must be taught *to want* to work safely. Strict enforcement penalties for safety rule infractions are desirable where imposed reasonably; frequently they prove a broken crutch leading to resentment and non-cooperation.

There are three "E's" to a safety program: Engineering, Enforcement and Education. Typical of one company's experience is the following: During the period 1942-1947 it had 678 accidents of all types, of which 116 were lost-time. In this category only nine accidents could be attributed to equipment failure; four from air line explosions, two by breaking gauge glasses, one from a leaking propane valve, one from a rupturing loading hose, and one by a mineral seal oil line breaking.

Mr. Ritter's comment was that if proper inspection had been made, or the employee was watching what he was doing, even these would not have occurred. The balance of the accidents were the usual ones of smashed fingers and toes, cuts, burns and strains from improper lifting. This company practices the three "E's" but, without the desire of the men themselves to work safely, accidents cannot be prevented. Management must continue to endeavor to instill this prime ingredient into its safety prevention formula, the speaker brought out.



crude thruput doubled . . gasoline octane level raised

CONTINENTAL
OIL COMPANY'S
DENVER
REFINERY

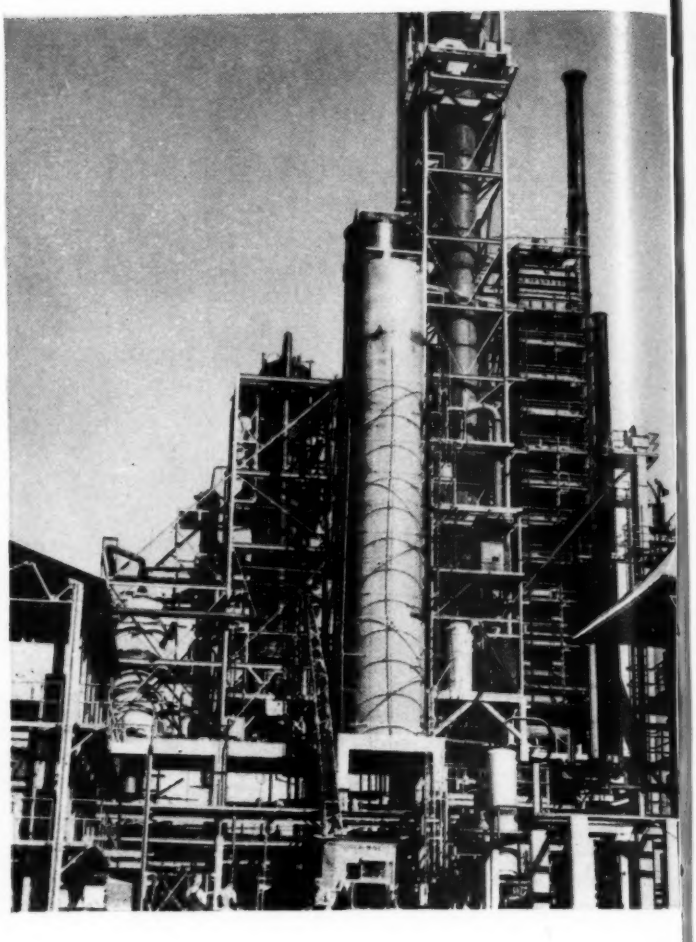
An interesting example of integrated expansion

The new Lummus-built catalytic cracking unit at Continental's Denver Refinery was recently completed. Despite unfavorable weather conditions it went on stream about the middle of November, and within two days it was operating at design capacity.

The catalytic cracking unit was part of an integrated expansion program that included the design and construction by Lummus of three other new units—gas recovery, catalytic polymerization, liquid propane gas fractionation—and the modernization by Lummus of a thermal cracking unit.

Continental's Denver Program is an interesting example of refinery expansion accomplished by integrating new units with modernized existing facilities. This program practically doubles the crude thruput at Denver and raises the octane level of the finished gasoline.

Lummus engineers are available for a thorough study of individual problems involving the modernization or expansion of existing facilities and the projection of new programs.



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Plant Practices

Practical Tips and Ideas for Improving Operations

Simple Method for Rebuilding Bottom Prolongs Storage Tank Service Life

By E. G. WOOLMAN, Assistant Mechanical Superintendent
Tutwiler Refinery, Cities Service Refining Corp.

IN many storage tanks for gasoline, naphtha, kerosine, gas oil, and crude oil, the bottoms have to be replaced after years of service because of corrosive action on the steel by sulfur, salt, and other chemicals. A method of construction developed and in use at the Tutwiler refinery of Cities Service Refining Corp. has proved both practical and economical in prolonging the life of tanks where the sidewalls and roof are still in good condition.

Essentially, the method provides a new bottom which is in the general shape of a huge pie pan with steeply sloping sides about 12 in. high. This assembly fits into the old bottom and is securely welded against leakage. The technique can be used on tank of any diameter, and the angle of slope of the slanting sidewall member can be varied as desired, up to say 45°. The procedure is as follows:

Steaming is first necessary to remove hazardous vapors. This is followed by cleaning the old bottom with sand or fullers earth. It has been found that with this particular construction method it is more economical to cut a slot in the tank wall instead of taking out a door sheet for moving in materials. A section about 6 ft. long by 6 in. high is cut out just above the bottom angle iron, making it quite easy to slide the 5 or 6-ft. wide steel plates through. Workmen enter by conventional manholes.

The drawings in Fig. 1 illustrate the construction in general. Steel plates, 1/4-in. thick, are used for both the bottom and the slanting side. They must all be laid out and cut properly before being taken into the tank. The layout position makes it possible to determine the arc of the plate ends. The plate ends are cut to a radius in the example shown that is 2-1/2 in. less than the original inside radius of the tank.

The sketch shows that the plates are overlapped with the exception of about 3 in. at one end and 2 in. at the other. At each end a notch is cut so that the adjoining plates are butt-welded to form a smooth, flat surface around the circumferential edge of the new bottom. On the re-

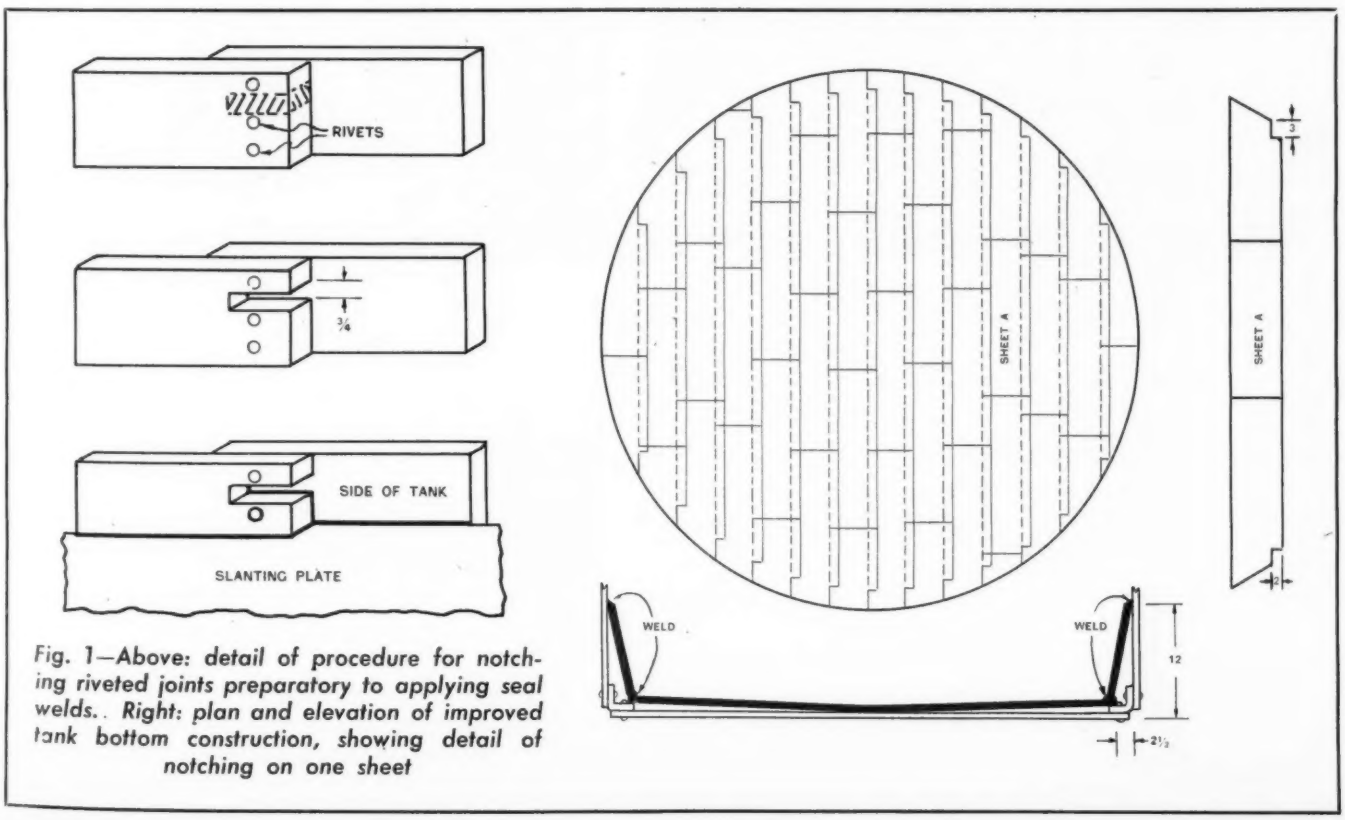

Fig. 1—Above: detail of procedure for notching riveted joints preparatory to applying seal welds. Right: plan and elevation of improved tank bottom construction, showing detail of notching on one sheet

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mainder of the seam, the plate is sealed with a fillet lap weld. Only one pass with a 3-16-in. mild steel electrode is used in making these two types of weld.

The slanting plate is primarily to take care of any corroded condition which might exist along the inside wall near the bottom. The slant tends to give the bottom a certain degree of flexibility which prevents undue loads or strains on the reconditioned tank bottom.

When the upper edge of the side plate is welded to the tank, a special welding procedure is necessary to avoid leakage which in the case of riveted tanks would be caused by the expansion and contraction of the rivets in the seams in each of the vertical joints of the sidewall. To overcome this problem, a notch 3/4-in. high and 3 in. long is cut as illustrated in Fig. 1. A welding bead is then run up the joint, around the notch and around the rivet heads. This prevents any liquid from seeping behind the rivets or running down the seam in back of the slanting plate.

After the new bottom has been installed, the section cut out to act as a door sheet can be tacked into place, since there is no need to make the weld leakproof because it is located below the slanting plate.

Exchanger and Reboiler Leaks Detected By Device Using Commercial Gas Alarm

BY adapting a standard commercial gas detector and alarm to a specially designed arrangement, instrument engineers at Atlantic Refining Co.'s Philadelphia refinery have developed a useful leak detecting device. The set-up is employed on heat exchangers and on reboilers where the hydrocarbon is under a higher pressure than the steam. It is illustrated schematically in Fig. 2.

A ¼-in. line is tapped into the steam source. Vapors are drawn through the system by means of an aspirator on the outlet side of the gas alarm. They pass through a water-cooled condenser coil and into a small vessel (a standard 6-in. diameter seal chamber) where condensed water separates from any hydrocarbons that may be present. A vapor line runs from the top of the seal chamber through a rotameter to the gas detector. This instrument is set to give an alarm at 20% of the LEL (Lower Explosive Limit). The rotameter serves as a check on proper flow through the system.

All piping and fittings are ¼-in. standard except where otherwise specified. The condenser coil consists of 12 turns of ⅜-in. O.D. copper tubing; each turn is 6-in. diameter. The seal chamber and the open-end ¼-in. condensate drip line are insulated to prevent freezing in cold weather. All other openings to the seal chamber except those in use are plugged.

The alarm instrument must be located at least 3 ft. above the top

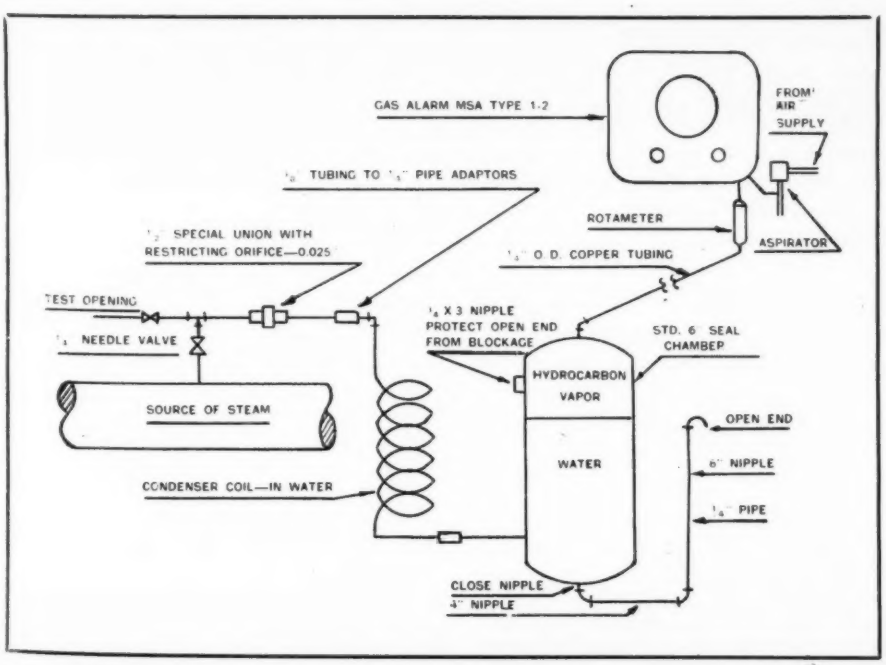

Fig. 2—Schematic diagram of Atlantic Refining Co.'s method for detecting leaks in heat exchangers and reboilers

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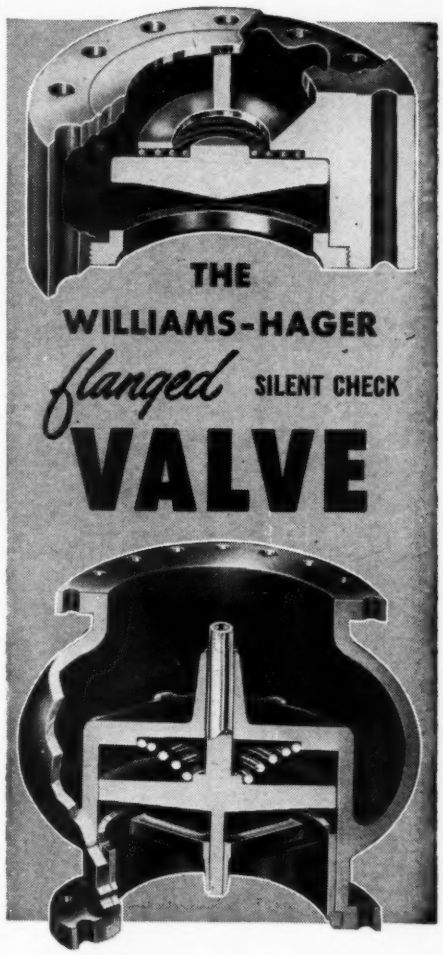

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of the seal chamber and not more than 6 ft. from the chamber. The test opening at the extreme left of the ¼-in. line is used to admit a measured quantity of hydrocarbon for purposes of testing the gas alarm instrument.

Propane Drawoff Safe to Use, Prevents "Burns" to Sampler

By JOHN C. ALBRIGHT

FEWER "burns" to personnel from extremely low temperature propane is said to be the result of an improved sampling draw-off on propane storage at the Aurora Gasoline Co. refinery in Detroit, Mich. The device permits the operator to obtain samples without having the propane coming into contact with his hands or fingers.

Essentially, the sampler is a miniature "cyclone" vessel, slightly larger than a common one-quart oil can. It is constructed of a reasonably heavy gage sheet metal so as to stand up under many months of continuous service. The barrel is cylindrical; the top and bottom heads are shaped as cones. A heavy inlet nozzle is brazed or soldered to one side on a tangent so the liquid entering is given a cyclonic action. The other end of this nozzle terminates in a standard pipe thread for easy connection to a conventional sample line.

The top head has an opening about one in. in diameter. The bottom opening is tapered down to a small point so as to fit inside the neck of a standard graduate of the type usually employed for obtaining liquefied petroleum gas samples. The device quickly frosts over after the sample line valve is opened, so that a very small amount of liquid is lost by evaporation.

IDEAS—Wanted!

Plant operators, foremen, engineers, superintendents!—Send in your own original contributions on "how we do it around the refinery." Possible subjects could be gadgets, operating shortcuts, safety and fire protection ideas, to name a few.

Material submitted for publication exclusively in PETROLEUM PROCESSING is paid for at the usual space rates. Include sketches or photos if possible. The idea is the thing—we'll dress it up.

Plant Practices Editor
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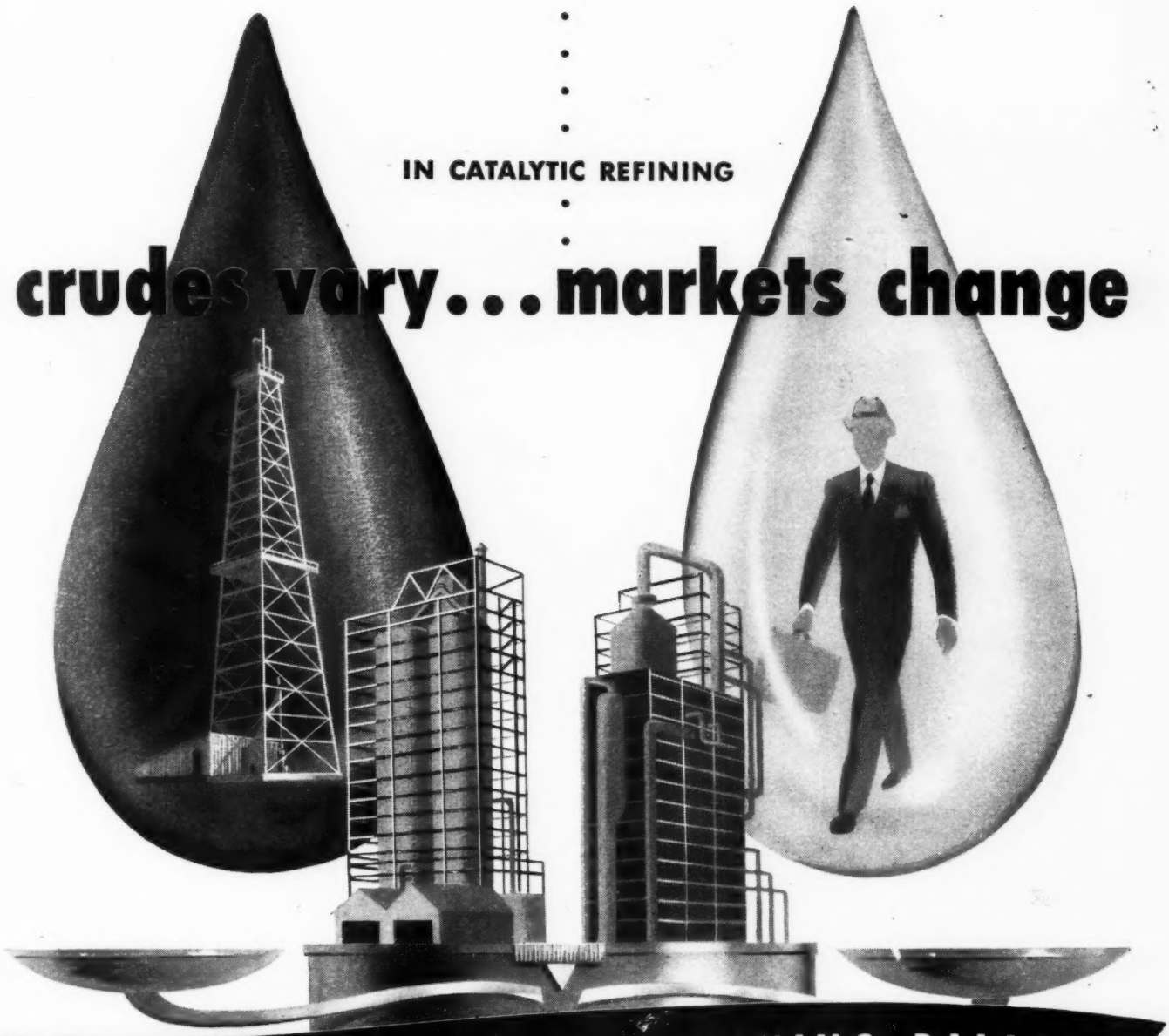
IN CATALYTIC REFINING

crudes vary... markets change



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Laboratory Practices

Automatic Controls Make Tester Useful For Short-time Screening of Greases

ADDITION of automatic recording and controlling instrumentation to a grease testing machine has made it possible for engineers at The Texas Co., Beacon, N. Y., research laboratories to use the equipment to good advantage as a quick screening test.

Essentially an apparatus for measuring the tendency for "breakdown" of grease and the starting and running torques of ball and roller bearings fully packed with grease, the machine itself was designed, built, and put into service by Beacon technologists 15 years ago.(1) With the recent changeover from manual to automatic control, the equipment has proved most useful in short-time screening. Testing of grease for longer duration is now carried out usually in machines specifically designed for endurance testing.

The photographs in Figs. 1, 2, and 3 illustrate the apparatus before installation of automatic controls. It consists essentially of a motor-driven shaft (A) held in position by pillow blocks and driven by motors (C) or (F). These motors may be of any speeds but for most of the work they have been operated at speeds of 900 and 1750 RPM.

Referring to Fig. 2, the ball bearing (D), a 4-in. size 211, is held on the shaft by the hub (H), which is pressed into the inner race. The hub is provided with a key-way which slides over the key (G) on the shaft. Shaft (A) is shouldered to prevent the bearing from sliding along the shaft. The end of the shaft is drilled and tapped for a 3/8-in. screw.

The bearing is locked to the shaft by a locking device, a ⅛-in. plate having a diameter the same as the inner race of the bearing. It is held against the face of the inner race by the ⅜-in. set screw in the end of the shaft. This plate together with the bolt and key-way on the shaft holds the bearing firmly to the shaft and thereby causes the inner race to revolve with the shaft.

The housing for the bearing, which has been designed to simulate clearances, etc. in actual practice, consists of two parts (K1) and (K2), which screw together. That part of the housing (K1) which is on the outside is sealed so that no leakage of grease occurs; but the opposite half of the housing (K2) has an opening slightly larger than the shaft diameter and is supplied with a cup arrangement (not visible in Fig. 2) to catch any grease which leaks out. By screwing the two halves of the housing together, the side pressure against the outer race holds the bearing in place in the housing.

To measure the torque, the housing is fitted with a torque arm (L), shown in Fig. 3, graduated to permit a wide range in torque measurements. By means of a system of levers (M), the force of the turning moment of the housing is registered in grams on platform scale (S). To measure the bearing temperatures, a calibrated thermocouple (N) is screwed into the housing so that the junction presses against the end face of the outer race.

To simulate high and low temperature operating conditions, the entire bearing and housing assembly has been provided with an insulated chamber (O), equipped with an insulated cover plate. This chamber is provided with a copper tubing coil permitting the circulation of isopropyl alcohol cooled by dry ice, yielding the low temperature range of room to −40° F. The cover plate has a calrod heating unit and a fan, giving a high temperature range of room to +300° F.

The operation of the machine with the automatic controllers and recorders is illustrated in Fig. 4, and described as follows. Two units comprise the temperature control: the time-pattern transmitter (F) and the controller (E). The pattern transmitter contains a rotating cam, shaped to provide the temperatures required. A cam follower riding the cam operates a flapper valve which in turn causes changes in the air pressure supply to controller (E). The cam is cut to dictate a time pat-

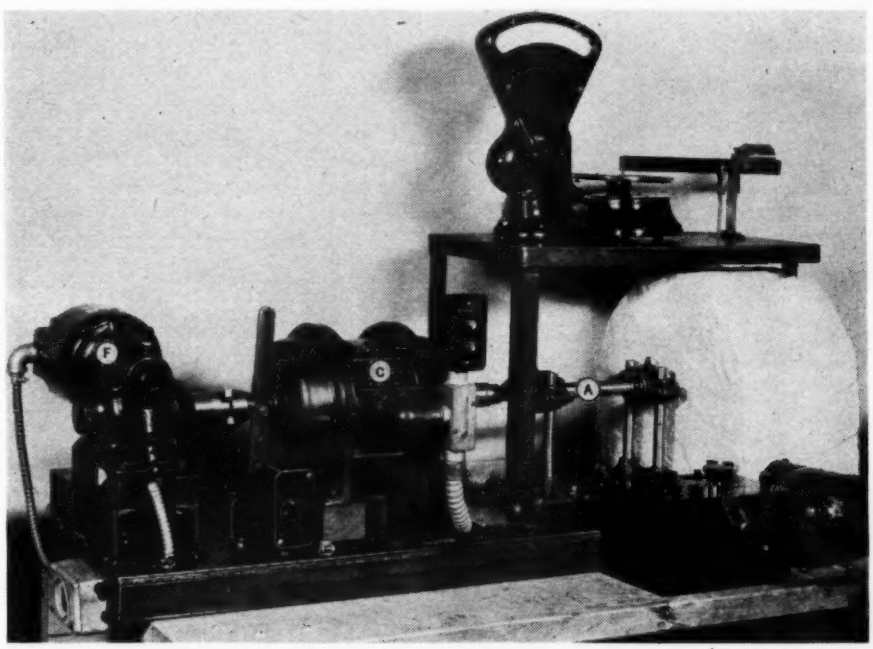

Fig. 1—General arrangement of the grease testing machine before installation of recorders and controllers

(1) "Machine for Evaluation of Ball and Roller Bearing Grease," *National Petroleum News*, October 19, 1938, p. R-502.

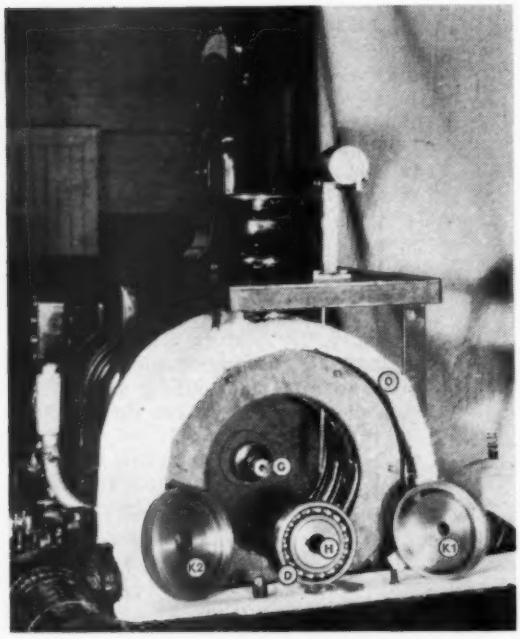

Fig. 2 — Left: end view of grease tester showing the housing assembly for ball bearings

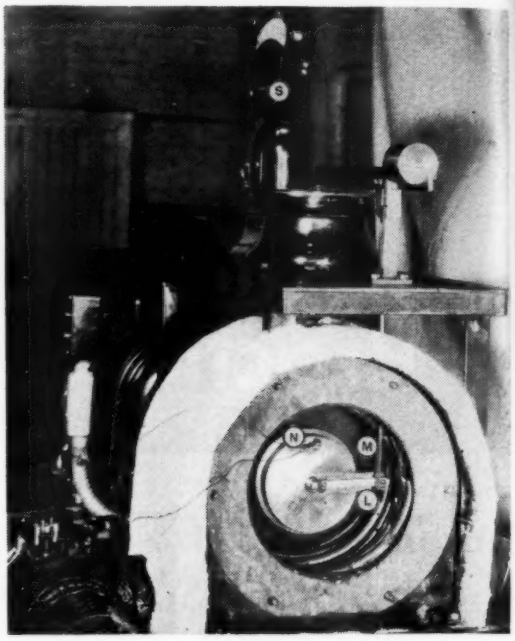

Fig. 3 — Right: end view of assembled machine showing torque arm, thermocouple, etc.

tern of a temperature rise from 80 to 250° F. in one hour and a constant temperature of 250° ± 2.5° F. for two hours, this being one of the standard test procedures. The temperatures of the bearing and test chamber are recorded on the Brown two point potentiometer (G).

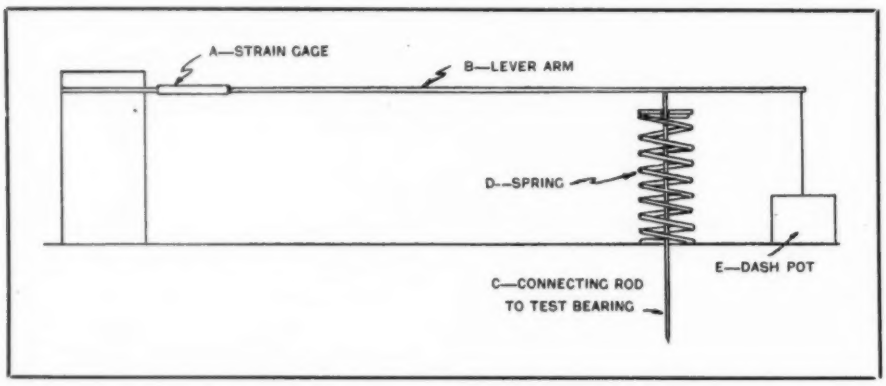

Fig. 4—Lever arm arrangement for measuring torque

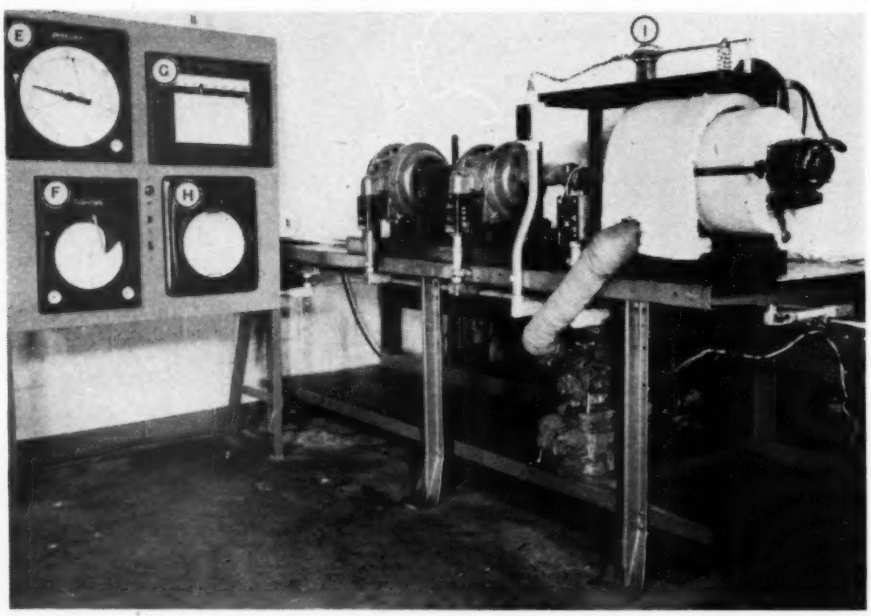

Fig. 5—Grease testing machine with automatic controls

The measurement and recording of bearing torque is accomplished by using Baldwin "SR-4" strain gages (I) and the "SR-4" strain recorder (H). Fig. 5 illustrates the apparatus for torque measurements. In that drawing, strain gages (A) are mounted on the lever arm (B). The torque from the test bearing is transmitted to the lever arm by connecting rod (C). Under the action of high starting torque the lever arm is deflected downward until it hits spring (D). The action of the spring is such to prevent excessive deflection of the lever arm. Under lighter running torques the spring is not used, as the arm is not deflected enough to hit the spring.

Lever arm deflection is measured by the strain gages, which consist of a fine wire which is changed in length under the action of the lever arm. The change in length of the wire alters its resistance, by which means the torque is converted to readings on the strain recorder through its electrical circuit. To prevent excessive vibration of the lever arm, a dash pot (E), filled with a suitable hydraulic oil is mounted in front of the lever arm.

The above description has covered the use of the machine on a ball bearing. A second housing designed so as to accommodate two opposed tapered roller bearings also may be used.

Acknowledgement

Information presented was taken from a paper, "Report on Testing Machine for Evaluation of Ball and Roller Bearing Grease," by Gus Kaufman, W. A. Prendergast, and R. F. Strohecker, The Texas Co., and presented at the annual meeting of the National Lubricating Grease Institute in Chicago, November, 1948.

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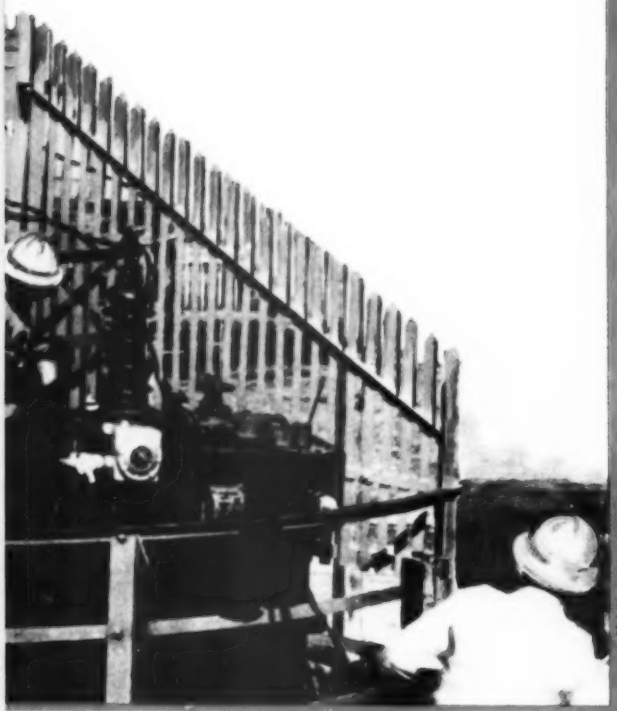

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Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

Are natural gasoline and cycling plant operators currently giving any consideration to improving the octane value of their product, such as might be obtained with catalytic processes for desulfurization or reforming?

Surprisingly enough, the answer to the above question in the majority of cases is NO. It is true of course, that the larger operators, by virtue of extensive fractionation equipment and careful segregation of the higher octane fractions, do give a good deal of consideration to octane value improvement. The average small operator, however, does not have such extensive equipment.

Due to the fact that butanes are being used for LPG and other profitable markets, the average vapor pressure of natural gasoline has fallen to approximately 12-16 lbs., thereby increasing the amount of natural needed by the refiner to meet motor fuel vapor pressure requirements. Accordingly, as this percentage of natural gasoline increases, so does the importance of its octane to the refiner.

Several gasoline and cycling plant operators, with an eye toward the increasing octane trend, have installed or are installing Perco Catalytic Desulfurization or Catalytic Reforming Units to realize premium prices for their products.

These units are upgrading natural and cycling plant gasolines from 5-9 octane numbers at the +3 c.c. TEL level. Below are plant data illustrating the octane enhancement achieved:

Catalytic desulfurization of natural gasoline (C_5 and lighter).

The combined iso-butane and heavier fraction from one natural gasoline plant is processed through the desulfurization unit. This process improves the quality of the butanes in that, after subsequent fractionation they contain no traces of mercaptan sulfur. The iso-butane, iso-pentane, normal pentane and normal pentane and heavier are fractionated. All products are doctor sweet, corrosion negative and very low in sulfur and gum, requiring no further chemical treatment. Properties of the feed and product are given in Table 1.

Catalytic reforming of cycling plant gasoline

In instances where a high octane "jump" is desired from cycling plant gasolines for blending purposes, catalytic reforming is desirable. One catalytic reformer processing a 10 lb. R.V.P., 410° E. P. cycling plant gasoline at 1025° F. is recovering 92% of the hydrocarbon charged. The rise in octane numbers secured is shown in Table 2.

Catalytic desulfurization of a straight-run natural gasoline blend

In one plant sour natural gasoline is injected into a crude pipeline and recovered after preheating the crude-natural mixture. The recovered natural is then blended with 400° E. P. straight-run gasoline before charging to a catalytic desulfurization unit. The blended product after caustic washing is sweet, non-corrosive and suitable for finished gasoline blended with the other refinery gasoline streams. Octane improvement for this operation is shown in Table 3—J. W. Sandberg, Perco Division, Phillips Petroleum Co., Bartlesville.

Data in answer to questions presented on these pages is supplied through the cooperation of authorities with the equipment and engineering companies of the Natural Gasoline Supply Mens Assn., among others. Readers are invited to submit queries on plant operating problems in their own work.

TABLE 1—Properties of Feed and Product*

	Feed	Catalytic Desulfurized Product
Doctor Test	neg.	neg.
Corrosion	neg.	neg.
Sulphur—%	0.06	0.003
Octane A.S.T.M. clear	63.0	63.0
Plus 1 c.c. TEL	68.6	73.0
Plus 2 c.c. TEL	72.5	80.3
Plus 3 c.c. TEL	74.8	82.5

* Basis: 10 lb. natural gasoline after removal of iso-pentane and lighter.

TABLE 2—Rise in Octane Numbers

	Feed		Catalytic Reformed Product	
	Motor	Research	Motor	Research
Octane A.S.T.M.				
Clear	59.6	59.7	68.0	71.4
Plus 3 c.c. TEL	81.6	81.8	85.0	88.0

TABLE 3—Octane Improvement

	Feed	Catalytic Desulfurized Product
Octane A.S.T.M. Clear	56.9	59.5
Plus 3 c.c.	68.4	77.5

What ratio of depth to diameter is recommended for solid desiccant bed?

In the design of a solid adsorbent bed for the dehydration of gas consideration should be given to the following factors: volume of gas, pressure, density or specific gravity, temperature of incoming gas, moisture content, liquid content, optimum flow rate through bed, permissible pressure drop through bed, desired dew point and regeneration cycle.

For most drying applications a desiccant approximating four to eight mesh (based on Tyler screens) is used. However, 0.5-in. to 0.25-in. sizes are readily available and frequently used where lower back-pressures are desired. Some engineers use a gradation of sizes in the same bed. The common practice today is to specify a bed depth or height of three to four times the diameter. Increasing the height of the desiccant bed will give an increase in the amount of total moisture removed but doing so will also increase the resistance to flow (pressure drop). For mechanical and process reasons, a two-tower unit is preferred to a single tower with double the height.

The flow of gas should be at a rate sufficient to allow the optimum contact interval with the solid desiccant in obtaining good adsorption and the desired gas dew point. Flow rates of 10 to 20 cu. ft. per hour per lb. of desiccant, or a face velocity of 40 ft. per min., usually are specified for a desiccant of the activated alumina type in maintaining maximum drying at high efficiencies. The moisture adsorptive capacity of activated alumina will be increased by lowering the temperature of incoming gas. Where inlet gases have a temperature of above 90° F, pre-cooling of the gas will result in better efficiencies in the drying bed.

With the adsorption of moisture there is a temperature rise (heat of adsorption) which, if not dissipated, may sharply decrease the overall adsorptive capacity. The quantity of heat liberated in the bed is a function of the moisture content of the gas. For practical purposes the heat of adsorption is usually considered equivalent to the heat required to vaporize an equal amount of water.—Boyd F. Koepke, Aluminum Co. of America, Dallas.

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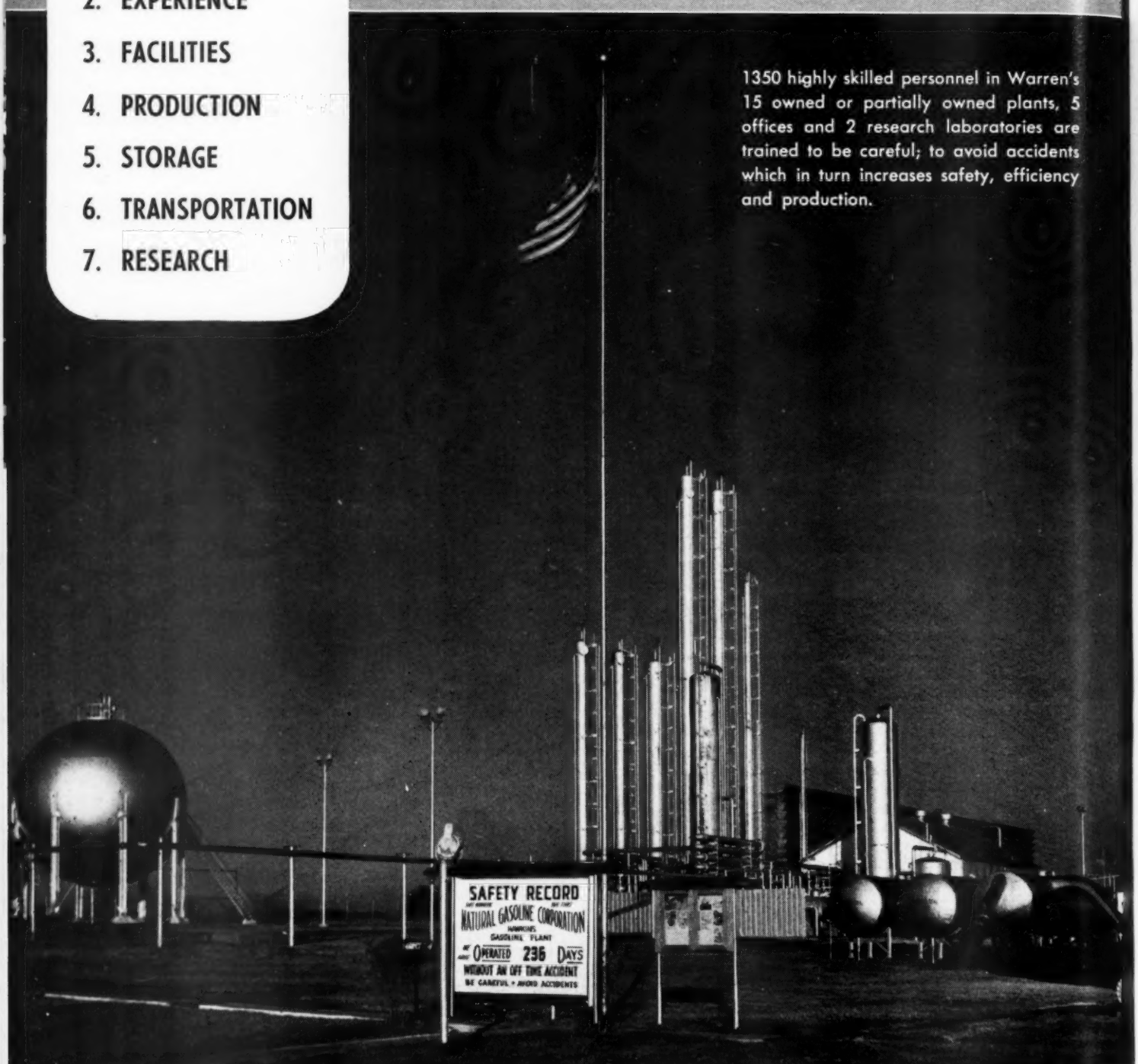

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Crude Oil, Natural Gasoline and Liquefied Petroleum Products

Patent Trends in Petroleum Refining

By PETER J. GAYLOR
Patent Attorney and Editor "The Technical Survey"

Use of Tannic Acid in Regenerating Spent Caustic

SOON AFTER OUR ARTICLE was published under this heading in the December issue (pg. 1219), a patent (U. S. 2,453,067) was noted as issued to Pure Oil Co., covering the use of tannic acid as an oxidation catalyst, together with a solubility promoter (other than tannic acid) for increasing the solubility of mercaptan in the hydroxide. Such promoters are cresylates, potassium isobutyrate, and other compounds used in the solutizer process.

As can be seen form Fig. 1, tannic acid alone (Curve B) somewhat increases the solubility of mercaptans in caustic (compared with Curve A). The addition of cresylates to caustic causes an appreciable increase in solubility (Curve C) which is still more pronounced when tannic acid is also added (Curve D). It will be observed that this patent is specifically limited to use with solutizer promoters.

Pure Oil has been covering other catalysts. In its U. S. 2,444,051 it employs 2,5- and 3,4-dihydroxy diphenyls as subsitutes for tannic acid. In U. S. 2,457,635, it uses 0.1-3% of a phenolic substance which is less effective than hydroquinone as an oxidation catalyst, together with 0.0001-1% of a soluble salt of copper, nickel, cobalt or iron.

Welding under Oil

IN MANY WELDING OPERATIONS, particularly those employing the electric arc, access of air is avoided to prevent oxidation of the metal. When nitrogen is employed as the "inert" atmosphere, hardening of the welded metal often occurs.

An Egyptian firm, Salvage & Marine Co. of Egypt, has been developing welding processes in which air is excluded and some time ago obtained U. S. patent 2,408,175 on a method of welding under the surface of water, such as beneath the sea. Due to the conductivity of the water, special precautions must be taken to prevent leakage of current from the electrode and to prevent electrolytic action between the water and the electrode.

Recently, the firm obtained U. S. Patent 2,455,441 in which a layer of oil is employed above the work to exclude air. Welds made in this manner are said to be softer and superior to welds made under water or in air. Thus, for example, cast iron parts which would otherwise crack during welding can be successfully welded in this manner.

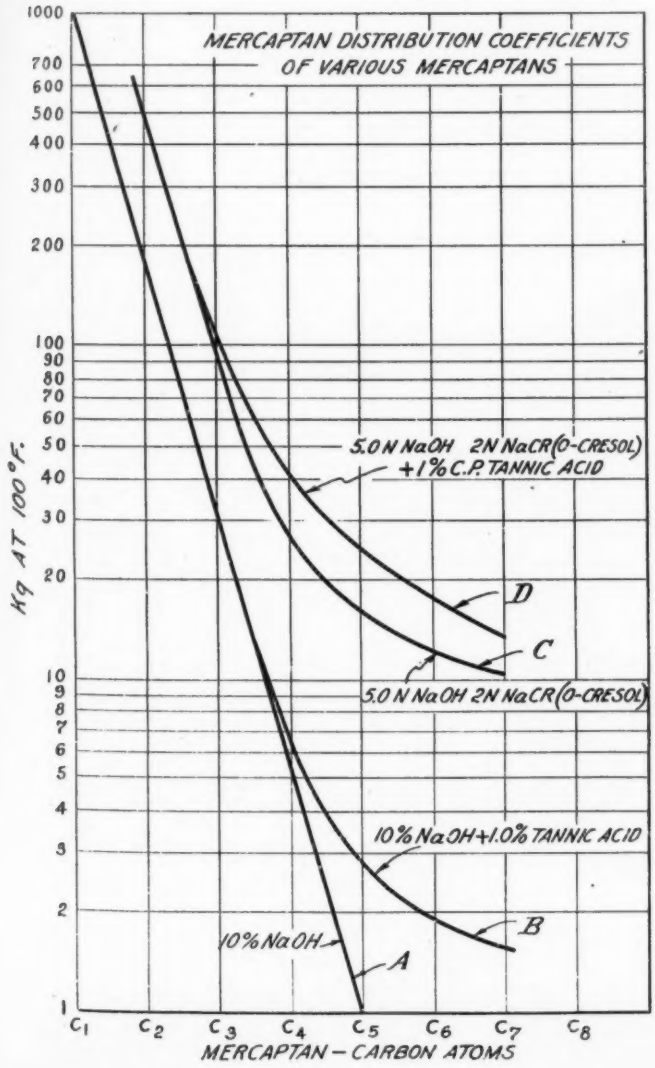


Fig. 1—Effect of Tannic acid as an oxidation catalyst in the removal of mercaptans (Pure Oil Co. — U.S. 2,453,067)

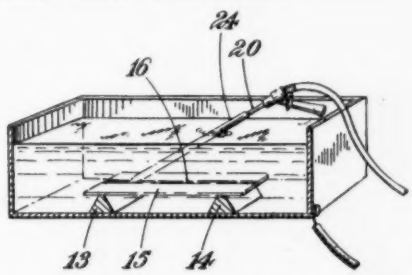


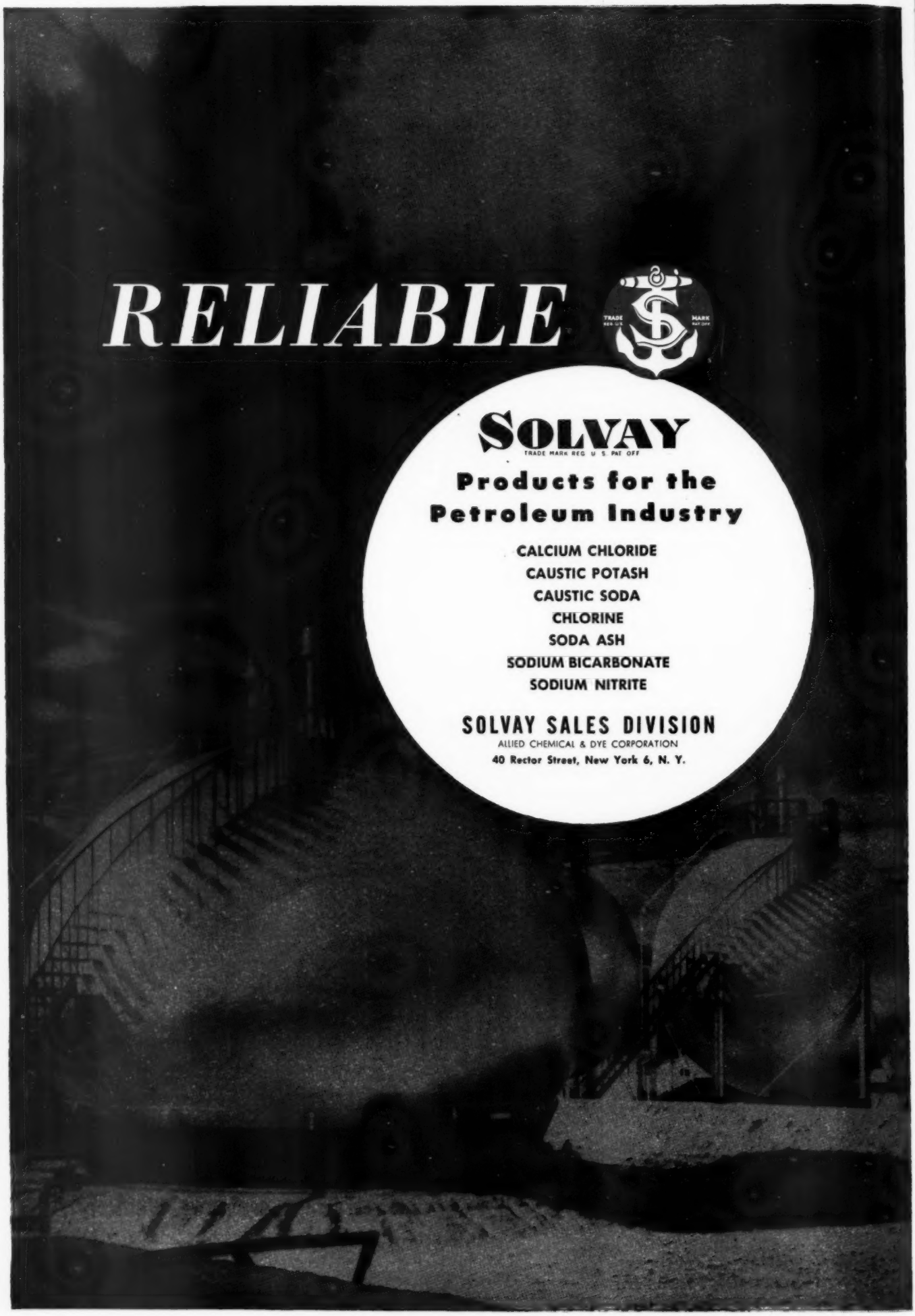
Fig. 2—Technique developed for welding under oil, the oil being employed to exclude air (U.S. 2,455,441)

Fig. 2 illustrates the manner in which the welding is carried out. The work 15 to be welded is placed on supports 13 and 14. The electrode 20, covered with the conventional coating of flux 24, is preferably given a coating of polyvinyl chloride to prevent the oil from penetrating the pores of the flux. Welding of seam 16 is then conducted in the conventional manner. Nothing is specified concerning discoloration of the oil by the arc.

Other Recent Patents

Below are presented brief reviews of other process and product patents issued recently and of interest to petroleum processors.

Improvement in catalytic cracking, consisting of charging with the powdered catalyst a powdered inactive material with a settling rate lower than that of the catalyst, the velocity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in the contact zone being maintained to carry out in suspension only inactive particles. U. S. 2,455,915; Walter H. Borcherding to M. W. Kellogg Co.

Catalytic cracking with a solid catalyst, in which quicklime is incorporated in the catalyst and contacted with carbon dioxide during the cracking reaction. U. S. 2,456,072; Milton M. Marisic to Pure Oil Co.

Catalytic cracking process in which the naphtha fraction from fractionation is contacted with contaminated catalyst in a separate stripping zone to displace high boiling hydrocarbons from the catalyst, the naphtha fraction then being introduced into the fractionation zone without passing through the reaction zone. U. S. 2,456,148; Davis Read Jr. to Universal Oil Products Co.

In a system for recovering olefins from a C_4 feed stock by contacting with sulfuric acid, the step of subjecting the sulfuric acid extract, after it has left the reaction zone and before it reaches the regeneration zone, to special heating conditions to improve the purity of the product. U. S. 2,456,260; Arthur A. Draeger to Standard Oil Development Co.

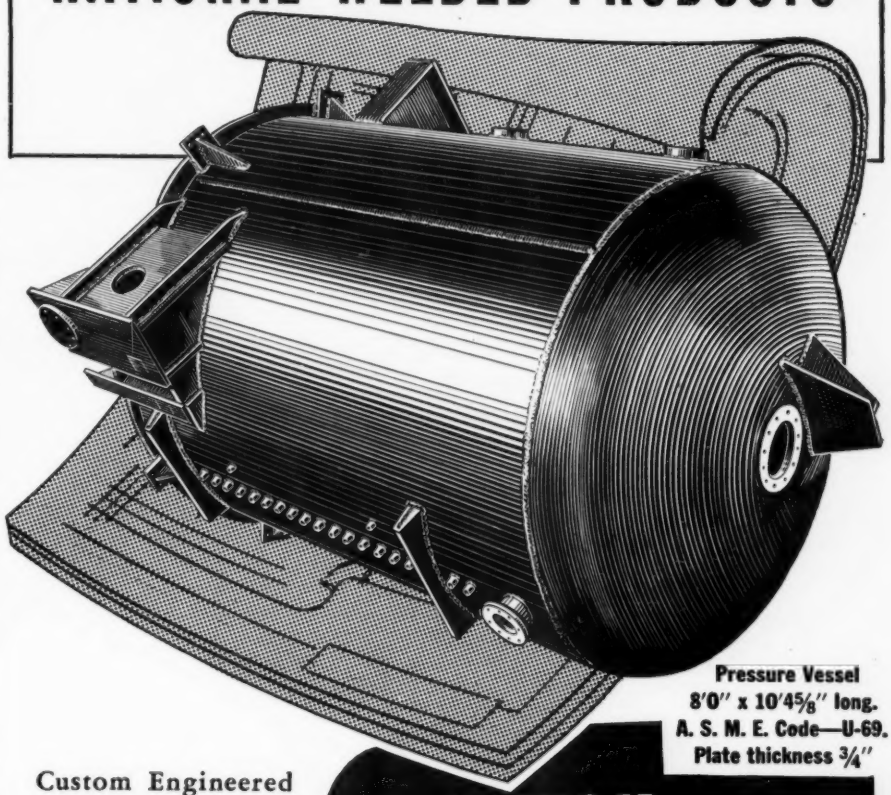
In catalytic cracking, charging a catalyst comprising a major portion of a synthetic cracking catalyst of relatively large size particles and a minor portion of fine clay, separately withdrawing a stream of catalyst from the bottom of the cracking chamber independently of the oil vapors. U. S. 2,456,306; Edward W. S. Nicholson to Standard Oil Development Co.

In shutting down a catalytic cracking unit, after the supply of hydrocarbon to the reaction zone is discontinued, the use of steam under prescribed controlled conditions to maintain the catalyst in the reaction zone in a fluidized state and to transfer it to the catalyst retention and regeneration zones. U. S. 2,456,310; Franklin M. Orr to Standard Oil Development Co.

Converting stabilizer gases from oil cracking to hydrocarbons within the gasoline boiling range, by separating the gases into a C_4 fraction and a fraction comprising chiefly C_2, C_3 and C_5 hydrocarbons subjecting the fractions to related catalytic polymerization reaction using a solid phosphoric acid catalyst. U. S. 2,456,-338; John J. Stadtherr to Pure Oil Co.

Production of branched chain hydrocarbons, by simultaneously dehydrogenating and isomerizing paraffinic C_4 or higher hydrocarbons, and reacting the resulting branched chain olefinic product with an alkylatable hydrocarbon to form a higher boiling branched chain hydrocarbon U. S. 2,456,672; Herman S. Bloch and Raymond E. Schaad to Universal Oil Products Co.

NATIONAL WELDED PRODUCTS



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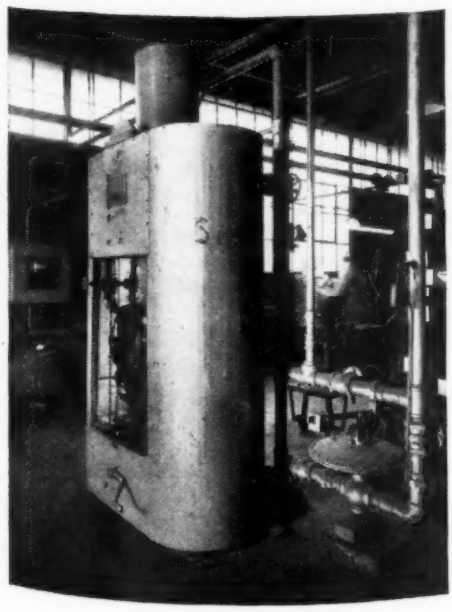

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Patent Trends

Process for stripping spent fluidized catalyst by the fluidization of the fouled catalyst with oxygen of not less than 95% purity. U. S. 2,456,707; Percival C. Keith to Hydrocarbon Research, Inc.

Catalytic cracking process comprising introducing a suspension of solid catalyst in a fluid organic reactant into the upper portion of reaction zone with a catalyst bed; passing the catalyst-reactant stream downward through the reaction zone; withdrawing the stream of reaction products and contaminated catalyst from the bottom of the reaction zone; transferring the stream by means of the pressure in the reaction zone to a higher separation zone; separating the reaction products and transferring the separated contaminated catalyst by gravity to a regeneration zone. U. S. 2,456,715; Frederick W. Leffer to Universal Oil Products Co.

Method for making petroleum coke by injecting particles of heavy oil into a current of heated gases under controlled velocity and temperature, coke particles above a predetermined size dropping out of the bottom of the reaction chamber. U. S. 2,456,796; August Henry Schutte to Lummus Co.

In an HF conversion process, the prevention of siliceous deposits by contacting overhead effluents showing such deposition with a drying agent to decrease the water content of the effluent to below the amount which is soluble in the condensed effluent. U. S. 2,456,348; Paul M. Waddill to Phillips Petroleum Co.

In catalytic conversion with aluminum chloride in an unpacked reaction chamber, maintaining a continuous circulating stream of hyrocarbon gases containing sublimed aluminum chloride in a closed circuit consisting essentially of the unpacked reaction chamber and an aluminum chloride dispersing zone into which fresh sublimed aluminum chloride is introduced. U. S. 2,456,557; Adam Deduszynski, Chester, England, to Shell Development Co.

Producing phenol by contacting, at a high temperature, a mixture of benezene gas and oxygen-containing oxidizing gas with a moving bed of solid porous adsorbent metal oxide catalyst. U. S. 2,456,597; Carleton H. Schlesman, William I. Denton and Richard B. Bishop to Socony-Vacuum Oil Co., Inc.

In the multi-stage regeneration of moving bed catalyst, an improvement consisting of recycling to the intermediate zones of regeneration a controlled amount of the gaseous products of regeneration, independently of the amount of regeneration gas supplied to the zone. U. S. 2,457,837; Thomas P. Simpson and Charles V. Hornberg to Socony-Vacuum Oil Co., Inc.

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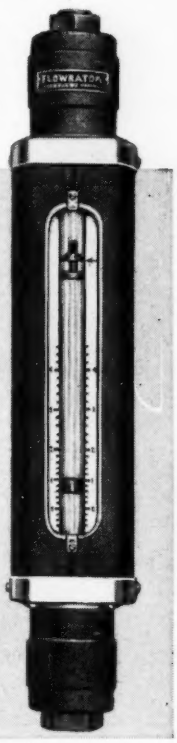
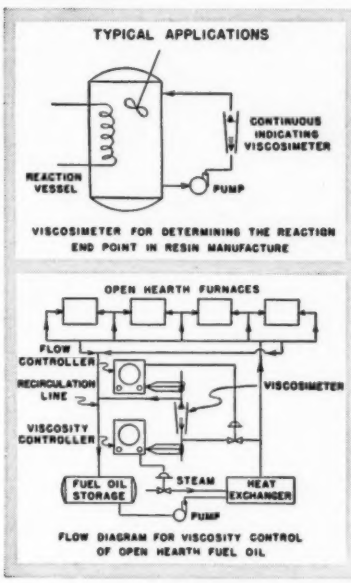




PRINCIPLE OF OPERATION

Continuous viscosimetry has been accomplished by utilizing one of the unique properties of the F & P FLOWRATOR meter (formerly rotameter): ability to make metering floats either viscosity sensitive or viscosity immune. Into one FLOWRATOR are placed two metering floats, the one so shaped that it is very viscosity sensitive, the other one with the patented F & P viscosity immune shape. When fluid flows upward through the tapered metering tube both floats will, of course, rise in the normal manner. However, the elevation of the one float will be relatively slight, since it is produced solely as a function of fluid flow rate. The other float elevation will be much greater since it is a function both of viscous drag and flow rate. The space increment thus created between the two floats is a direct measure of viscosity. By selecting any particular flow rate which will give a convenient elevation of the one float to serve as a reference line, the other float elevation may be marked as viscosity graduations in terms of centipoises, centistokes, S.S.U. or any other desired units. Viscosity measurement all the way from .0008 to 800,000 centipoises is now possible.

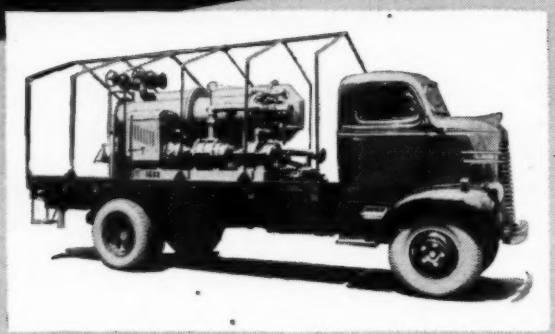
Write for catalog 88 giving much additional information. F&P VISCORATOR continuous viscosimeters have been thoroughly tested in trial installations for well over a year.

FISCHER & PORTER CO.
DEPT. 9M-1Z HATBORO, PA.

FLOWRATOR
TRADEMARK

FOR PORTABLE OR STATIONARY PROTECTION...

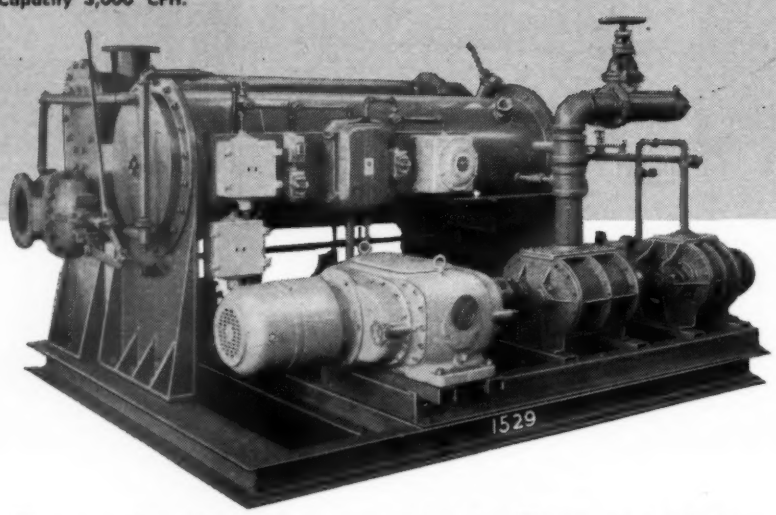
R-C Inert Gas Generators



Portable R-C Inert Gas Generator, of 15,000 CFH capacity, mounted on pneumatic-tired truck.

★

Stationary R-C Inert Gas Generator mounted on steel base. Capacity 3,000 CFH.



You can reduce the hazards of processing, handling or storing inflammable gases or liquids with R-C Inert Gas Generators. They produce cheaply a mixture of nitrogen and carbon dioxide, using oil or gas as fuel. Both fixed and portable units have these outstanding advantages:

1. Large capacity in terms of weight and cost.
2. Low operating and maintenance cost.
3. Quick adjustments for complete combustion.
4. No adjustments, for same fuel, needed after shut-down.
5. Operation not affected by variation in back pressure.
6. Extremely quiet operation.

With capacities from 1,000 CFH to 50,000 CFH, R-C Inert Gas Generators provide quick, dependable protection, at low cost. They are equally efficient, also, for inert gas production for processing operations. Write for details in Bulletin 100-B-14.

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ROOTS-CONNERSVILLE BLOWER BUILDERS R-C SINCE 1854

BLOWERS • EXHAUSTERS • BOOSTERS • LIQUID AND VACUUM PUMPS • METERS • INERT GAS GENERATORS

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Patent Trends

Process for converting ethylene to ethyl alcohol, by subjecting ethylene to the action of an aqueous solution of hydrogen fluoride and boron trifluoride, at between 200 and 300 C. and at pressure sufficient to maintain the aqueous solution in liquid phase. U. S. 2,457,882; Frederick E. Frey to Phillips Petroleum Co.

Process for removing mercaptans from a sour light naphtha substantially free from phenols, by contact with a caustic alkali solution containing phenols as a solutizer to increase the solubility of mercaptans, controlling the phenol content of the caustic solution by contact with a stream of heavy naphtha containing a higher concentration of phenol than the light naphtha. U. S. 2,457,975; John A. Bolt to Standard Oil Co. (Indiana).

Method for recovering MF from an azeotropic mixture with water, which comprises cooling the mixture to form crystals, melting the crystals and passing to fractional distillation. U. S. 2,458,044; Cruzan Alexander to Phillips Petroleum Co.

Process for separating olefin from paraffin hydrocarbons by contacting with a solution of a silver salt in acetonitrile. U. S. 2,458,067; Bernerad S. Friedman and Russell F. Stedman to Universal Oil Products Co.

Producing diolefins by contacting a mixture of butenes and 5 to 10 vol. % of 5 carbon atom hydrocarbons more saturated than diolefins, at 1000 to 1300 F., with a dehydrogenation catalyst in the presence of steam. U. S. 2,458,082; Myron O. Kilpatrick to Phillips Petroleum Co.

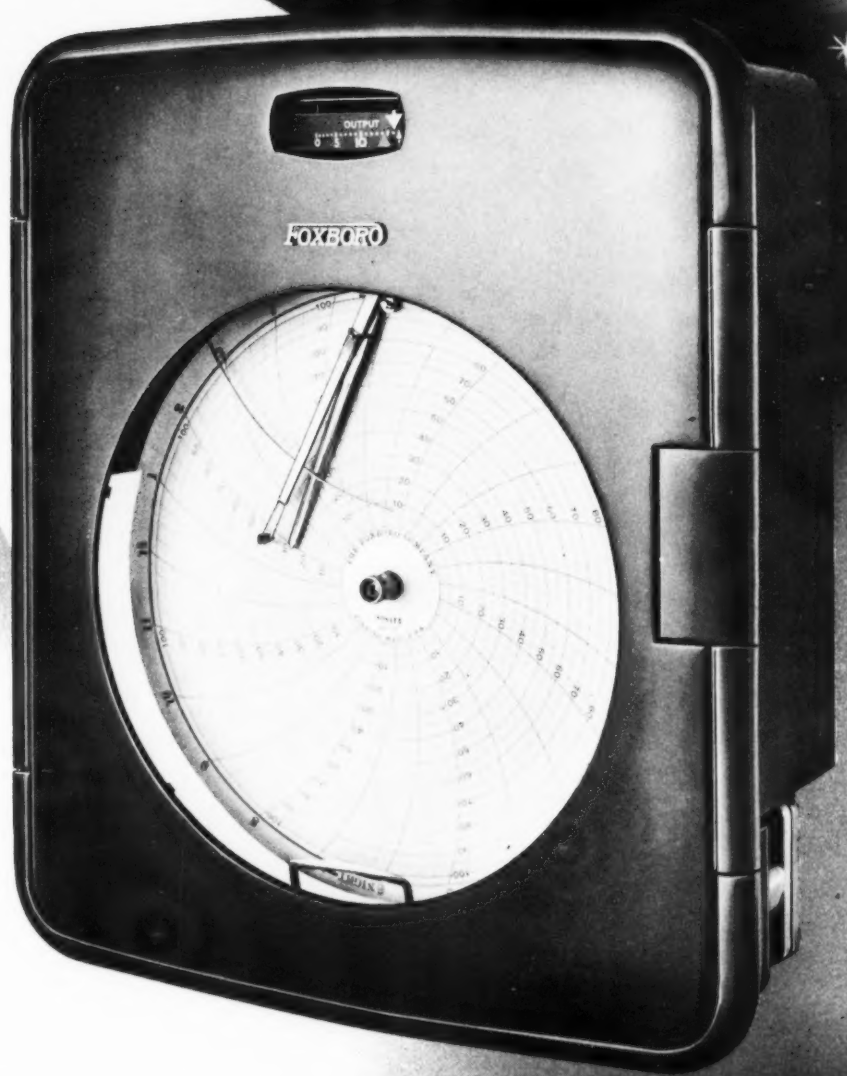
Moving bed catalytic cracking of heavy oil into gasoline, the oil charge containing a substantial fraction boiling above the desired reaction temperature; the heat of the catalyst in the conversion zone and the temperature of the charge oil being proportioned to maintain the conversion zone at a desired reaction temperature between 800 and 1000 F. and not above the boiling point of the substantial portion of the charge oil. U. S. 2,458,109; Thomas P. Simpson to Socony-Vacuum Oil Co., Inc.

Moving bed catalytic cracking of a high boiling liquid hydrocarbon, by injecting the charge oil in spray form into a shower of catalyst particles in the upper portion of the conversion zone to contact the catalyst particles before reaching the surface of the catalyst bed. U. S. 2,458,162; William A. Hagerbaumer to Socony-Vacuum Oil Co., Inc.

Catalytic cracking apparatus design comprising a vertical cylindrical conversion chamber, vertical cylindrical regentration chamber superimposed above the conversion chamber, a stripping chamber in the lower portion of the conversion chamber. U. S. 2,457,232; Robert J. Hengstebeck to Standard Oil Co. (Indiana).

AN "EYE-OPENER" IN

Accessibility



NO GROPING for concealed adjustments! No "sweating out" of awkward alignments! No haphazard arrangement of parts to cause confusion! Everything about the Foxboro Model 40 Controller is designed for orderly accessibility as well as precision.

With the door opened, operating controls are all conveniently grouped in the upper right corner. *Instantly accessible!* Pressure reducing valve and transfer switch are equally handy. Simple removal of chart plate (no tools, no pen-removal) makes all working parts easy to reach . . . with unit construction throughout to insure automatic re-alignment, even after disassembly and reassembly.

This outstanding accessibility is only one of many advantages that result from top-to-bottom new design that makes M-40 the finest modern controller!

FOXBORO
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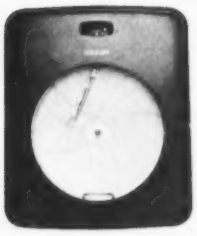
M-40

"THE FINEST MODERN CONTROLLER"



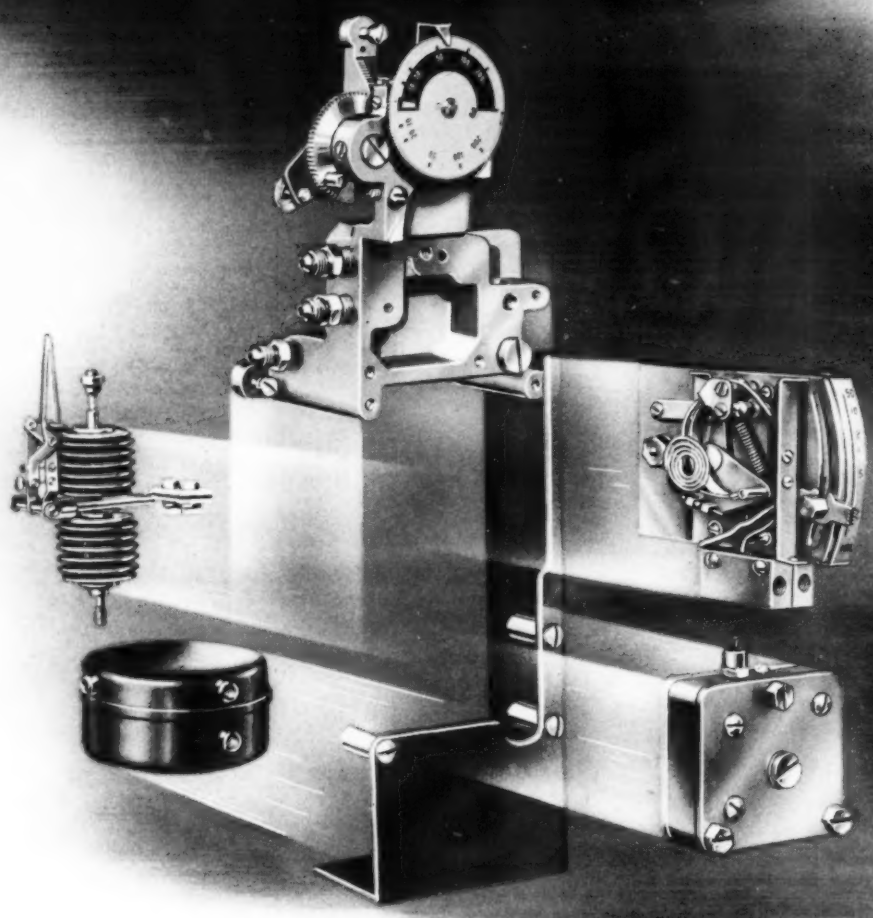
The Model 40 Pneumatic Controller is available for temperature, pressure, flow, liquid level, humidity, density, etc., in a full range of control actions and combinations. Write for Bulletin 381.
The Foxboro Company, 262 Neponset Avenue, Foxboro, Mass., U. S. A.

The only control unit with

PERMALIGNED CONSTRUCTION

The complete Model 40 control unit incorporating flapper and nozzle, control relay, hydron system and resistances is actually a series of sub-assemblies mounted on a single, solid base casting. Because of its overall unit construction, sub-assemblies as well as the entire unit may be removed or replaced easily and quickly without destroying original alignments.

Here's a typical example of the *permaligned* construction throughout the M-40 Controller . . . another important reason why instrument men recognize the M-40 as the finest modern controller.



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M-40

"THE FINEST MODERN CONTROLLER"

Radiant Energy Aids Separation Of Constant Boiling Mixtures

In addition to the radiant energy apparatus for separating constant boiling binary mixtures described below, this month's review of new and improved devices used in petroleum processing and handling operations on which patents have been issued recently includes:

- **Stationary vanes not used in catalyst separator design**
- **Photocell device adjusts heat input to laboratory still**
- **Partial pressure is principle of new hydrogen meter**
- **Vapor pressure is basis of fractionation control**

SEPARATION OF TWO compounds having almost identical boiling points, or those which form constant boiling mixtures, can be accomplished by use in the fractionating tower of a coil or coils supplying high frequency radio waves. It is based on the fact that chemical compounds having the same vapor pressure differ in their absorption of radiant energy. The radiant energy can therefore be utilized to maintain one component in a liquid state while converting the other to a vapor state or vice versa, or to maintain one as a liquid while converting the other to a solid.

One form of the invention is shown in Fig. 1. In operation, vapor consisting of two components passes upwardly from the main fractionator through packing 16 into the zone 17, in which there is a multiturn solenoid 18 made of copper tubing. Water, or some other temperature control medium, is passed through this coil. The two components with similar boiling points pass over the coil in vapor form at a temperature at which the liquid and gas phases are in equilibrium.

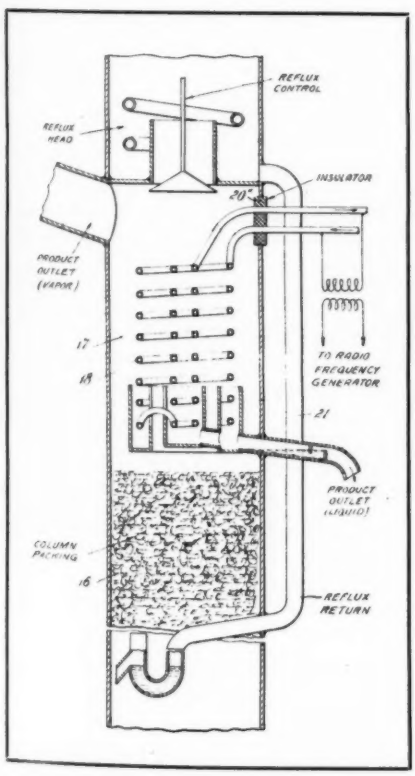


Fig. 1—Radiant energy from coil 18 separates two components with identical boiling points (U. S. 2,455,812)

For example, for water at 760 mm. pressure, this is 100° C.: the one component reaching the coil which is slightly cooler than the vapor, condenses. The other component receives sufficient energy from the radiation field to keep it in vapor form, and to superheat the vapor slightly. This component passes out of the zone in the form of vapor.

To insure complete separation of the components, any part or all of the component remaining in vapor form may be admitted to the reflux head and after condensation returned for recycling by conduit 21.

Advantage cited for the method is that it can be carried out in the top of a conventional fractionation column during normal distillation without adding azeotrope forming agents, solvent extraction or chemical reaction agents, and then later recovering such added reagents.

U. S. 2,455,812, issued Dec. 7, 1948, to Carleton H. Schlesman, assignor to Socony-Vacuum Oil Co., Inc.

Stationary Vanes Not Utilized In Catalyst Separator Design

MORE COMPLETE separation of catalyst particles from hydrocarbon streams at lower maintenance cost is said to be obtained in an improved centrifugal separator which does not use conventional stationary vanes. Such vanes represent a costly replacement item that is eliminated in the new design which features reduced erosion of separator internals. A cross-sectional drawing is shown in Fig. 2.

Catalyst-laden gas comes in through pipe 10, passes out through its flared lower end and strikes the inside of bowl 12, which is rotated by a motor or turbine 14. Vanes 18 on the rotating bowl help create the desired centrifugal action. The heavy catalyst particles are ejected outwardly against the wear plates 30 which line the inside of vessel 20, while the gas passes upwardly and is removed through line 22. Catalyst particles drop through the four large ducts 26 and out through line 23. Any gas occluded in the separated solids escapes by means of line 28 to the upper portion of the vessel 20.

Chief point of erosion is at the wear plates 30, which are readily removable, and are made preferably of some hard-surfaced material such as glass or stellite.

U. S. 2,456,329, issued Dec. 14, 1948, to Erlo F. Schoder, assignor to Standard Oil Development Co.

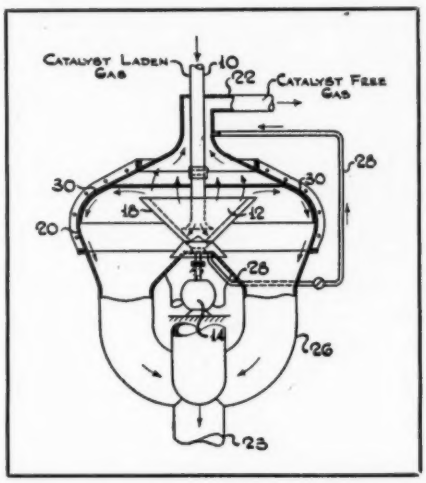
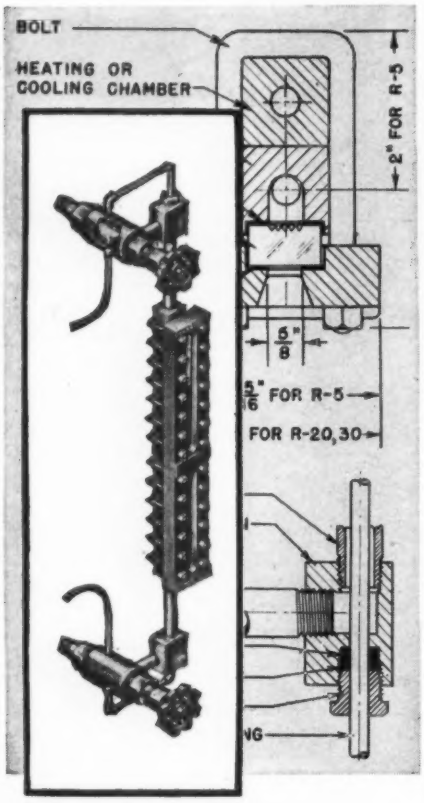


Fig. 2—Centrifugal action in improved catalyst separator is furnished by revolving bowl 12 with vanes 18 (U. S. 2,456,329)

Photocell Device Adjusts Heat Input to Laboratory Stillpot

GRADUAL AUTOMATIC control of heat to the stillpot of a batch or a continuous still as used in the laboratory can be had by means of an arrangement as illustrated in two forms in Fig. 3.

Variations in internal tower pressure are registered by the level of the mercury in manometer tube 13. The apparatus is arranged so that light from lamp 10 passes through the lens 11, or a slit 16, and the manometer tube before striking photoelectric cell 15. The light strikes the



JERGUSON HEATED AND COOLED GAGES

Give Accurate Readings Under All Conditions

USE Jerguson Heated Gages for accuracy if you are dealing with high viscosity liquids that flow sluggishly.

On the other hand, if you are dealing with highly volatile liquids which tend to boil, use Jerguson Cooled Gages with circulating cooling medium.

In either case, Jerguson engineers have the answer, with a complete line of gages that give accurate reading of *all* liquids under *all* temperature conditions.

Jerguson Heated-Cooled Gages are made in internal tube and double chamber models for all pressures.

Illustration shows Internal Tube Model, Reflex Type, with No. 93 Valves. Write for Data Unit No. 17.

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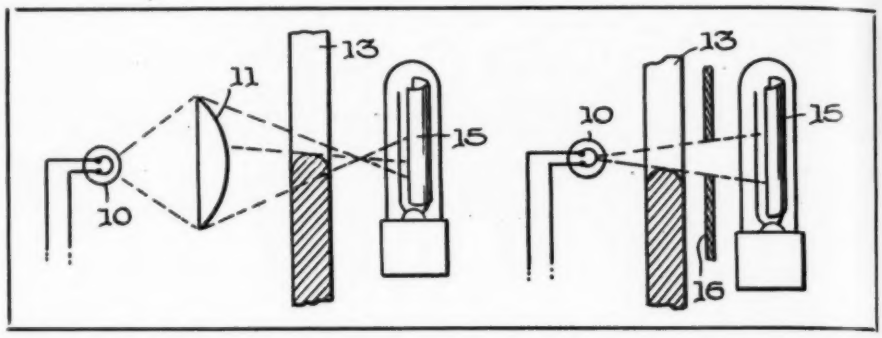


Fig. 3—Photo cell 15 regulates heating current in a stillpot with variations in mercury level in tube 13 (U. S. 2,455,243)

photo cell in degrees of intensity varying with the height of the mercury in tube 13. Resultant variations in the photo cell current are used to control the electric load on the stillpot heater.

It is possible to utilize instruments other than a manometer. For example, the pointer on a Bourdon gage can be replaced with a vane, which will serve to interrupt the light beam in varying degrees.

U. S. 2,455,243, issued Nov. 30, 1948, to Edward H. Epprecht, assignor to Gulf Research & Development Co.

Partial Pressure Is Principle Used in New Hydrogen Meter

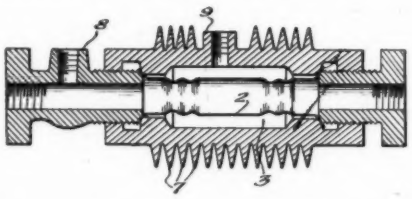


Fig. 4—Permeability of metal tube 2 provides for metering hydrogen concentration (U. S. 2,456,163)

HYDROGEN CONCENTRATION in a given confined zone or a flow stream can be measured with reasonable accuracy by determining the partial pressure of the hydrogen in the gaseous mixture by using a hydrogen permeable metallic partition, which will not pass liquid materials. A meter based on this principle, and similar in operation to an osmotic pressure measuring device, is illustrated in Fig. 4.

The fluid stream flows through from left to right. Thin tube 2, made preferably of palladium or platinum, permits the passage of the hydrogen present in the stream. The ratio of readings on pressure gages inserted at 8 and 9 provides a measure of the percentage of hydrogen.

Cooling fins 7 prevent overheating the housing when subjected to excessive gas temperatures. Tube 2 is corrugated to handle thermal expansion and contraction effects. When the fluid stream is at low temperatures, the accuracy of the device can be improved by installing a small electrical heating element in annular space 3, because the permeability to hydrogen of the palladium or platinum is increased when hot.

U. S. 2,456,163, issued Dec. 14, 1948, to Charles C. Watson, assignor to Universal Oil Products Co.

Vapor Pressure Control Basis For Improved Fractionation

CLOSER FRACTIONATION in commercial columns, where it is required to separate materials of relatively close boiling points, can be accomplished by basing the regulating instrumentation on the vapor pressure characteristics of the desired cut as compared to the vapor pressure characteristics of the next higher or next lower components of the charge mixture.

In conventional practice, separation is controlled by three methods: 1) control of general operating temperature-pressure level, 2) control of reflux ratio, and 3) control which sets the product composition by adjusting the heat and material balance. The invention involves the employment of all three, but features improvements in the third method.

It adjusts the heat and material balance by a pressure-sensitive instrument available commercially, and known as a "hydron," comprising two bellows, one within the other. A reference fluid is contained in the internal bellows and the tower vapors

How to Obtain Patents

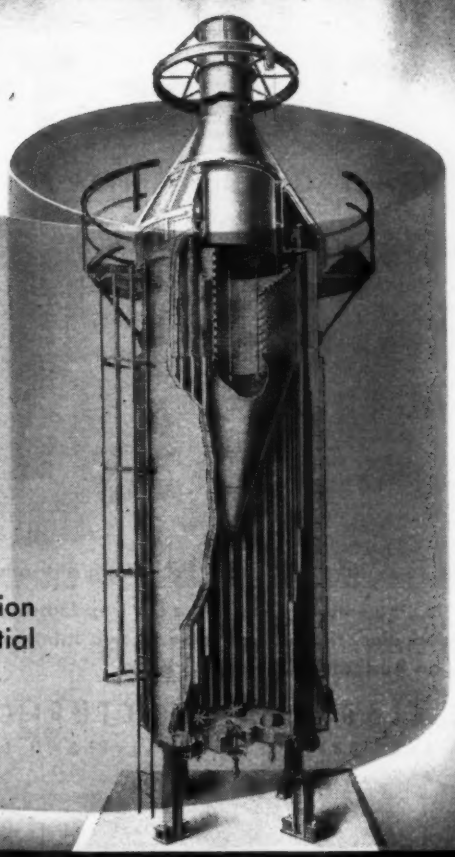
Readers may obtain copies of any U. S. patents from the Patent Office at 25 cents each. Order by patent number direct from: The Commissioner of Patents, Washington 25, D. C.

Petro-Chem Iso-Flow Furnaces

Pre-Eminent

For Multi-Pass Operation . . . .

Uniform heat distribution per pass being a most important essential to efficient operation of multi-pass furnaces, it is significant that Petro-Chem Iso-Flow Furnaces are unequaled for uniform heat distribution per pass because their cylindrical design and vertical tubes provide a perfectly symmetrical pattern on the fluid and combustion sides, regardless of the number of passes required.



Each bank of tubes (each pass) is equi-distant from the flame.

●

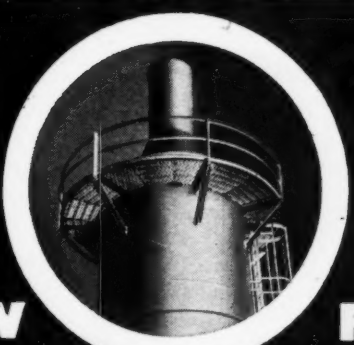
Each bank of tubes (each pass) is exposed to the same heat intensity.

●

Length of fluid travel for each pass (including crossovers) is identical from inlet to outlet.

●

All of the above give the minimum variation in tube wall temperature and are essential for critical high temperature operation.



PETRO-CHEM ISO-FLOW FURNACES

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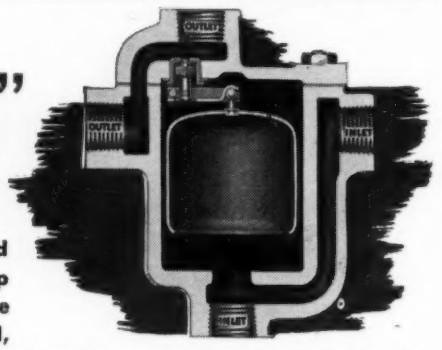
The Versatile
CLARK "60"
STEAM TRAP



The ever increasing demand for the new CLARK "60" Steam Trap proves that Clark engineers "hit the jackpot" again on this one! It is small, costs less, yet it does a *better job* in *more places* than any other trap in its class!

The CLARK "60" is "the small trap with the big trap features" such as positive seating with guided disc. It is equipped with two inlets and two outlets for easy installation on horizontal or vertical lines.

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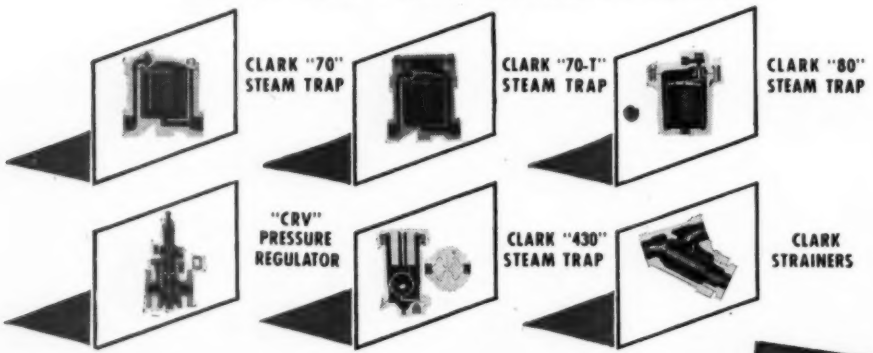

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exert their pressure effects on both bellows by passing into the annular space between the two. The resultant motion is transmitted to control mechanisms on the control valves in the bottoms, overhead vapor, or reflux lines, whichever may be desired.

U. S. 2,456,398, issued Dec. 14, 1948, to Clarence G. Gerhold, assignor to Universal Oil Products Co.

Other Recent Patents

Space does not permit the complete review of all patents issued recently on equipment for the petroleum processing industry. Following, however, are brief abstracts of those with the greatest interest:

Thermal Cracking Furnace, designed primarily for obtaining ethylene from propane, in which need for customary convection heating tubes is eliminated and tube replacement in general is said to be decreased. U. S. 2,456,787, issued Dec. 21, 1948, to Ludwig Kniel, assignor to Lummus Co.

Coking Unit for manufacturing coke from heavy hydrocarbon residues, production in which is illustrated by a given example indicating coke yield at 12.2% of charge weight based on a 4000 b/d charge of 12.5° API oil. U. S. 2,456,796, issued Dec. 21, 1948, to A. H. Schutte, assignor to Lummus Co.

Catalyst Disengager for moving-bed type catalytic cracking units in which improved separation of fines is obtained within rather than outside the reactor or regenerator shell, thus reducing carryover of particles in effluent vapors. U. S. 2,457,098, issued Dec. 21, 1948, to Ernest Utterback, Edward L. Sinclair and John A. Crowley, Jr., assignors to Socony-Vacuum Oil Co., Inc.

Centrifugal Pump in which inefficiencies due to eddy currents in the discharge pipe are reduced by separating the outlet line into two or more separate passageways, thus constraining every portion of the outgoing fluid to a predetermined path. U. S. 2,454,390, issued November 23, 1948, to Oystein Jacobsen, assignor to The Duriron Co., Dayton, Ohio.

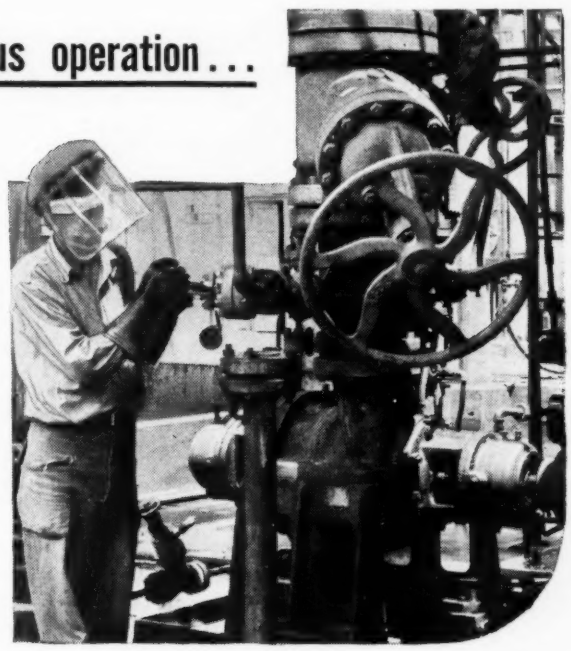
Fluid Catalytic Cracking Unit in which the reactor and the regenerator efficiency is increased by employing a combination of rotating blades and stationary vanes in each vessel, operated by a vertical drive shaft. U. S. 2,453,592, issued November 9, 1948, to David H. Putney, assignor to Stratford Development Co., Kansas City, Mo.

NH_3 $NaOH$ $NaCl$ H_2SO_4 H_2S

HOW *SELLERS* VALVES CONTROL THESE SEVERE CORROSIVES...

HCl HF

New positive shut-off valve gives continuous operation...



Five years ago, the Sellers Injector Corporation installed the first of their new valves for controlling harsh chemicals used in petroleum processes.

Since then, over 1,200 have been put into service... 1,200 positive shut-off valves in lines carrying corrosives from hydrofluoric acid to brine.

Performance? The Sellers Injector Corporation can show you proof that only 4 per cent have required minor repairs. And—*in every case*—positive shut-off was obtained when required.

Let's look at one of these valves in HF service:

The body and bonnet are cast steel, but all the other vital parts—*stem, plug, seat, back seat, lubricators, lock nuts* and *packing glands*—are MONEL*.

This liberal use of Monel is important. In hydrofluoric acid service, for example, those Monel parts were subjected to a constant boiling mixture at 230-300° F. under pressures of 75-110 psig. At the end of 5 years, they were still on the job!

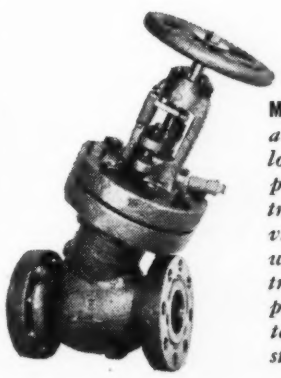
And Monel withstands such commonly-met corrosives as sulfuric acid, caustic soda, hydrogen sulfide, anhydrous ammonia, salt water and brine—and dilute concentrations of hydrochloric acid which result from electrolysis of brine in crude.

For complete information about Sellers Monel-trimmed Positive Shut-off Valves and their special, easy maintenance features, write *Sellers Injector Corporation,* 1600 Hamilton Street, Philadelphia 30, Pa.

*Reg. U.S. Pat. Off.

THE SELLERS MONEL-TRIMMED VALVES *described in the accompanying text are designed to provide the flow characteristics of gate valves, the facility of repairing globe valves, and the positive shut-off of properly functioning plug cock valves.*

• • •



MULTIPLE SEATING SURFACES *assure greater tightness, longer life and increased dependability. Sellers Monel-trimmed valves are also provided with a bottom pocket which acts as a trap for entrained solids and corrosion products. This not only protects the valve, but downstream equipment as well.*

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That's the kind of speedy fire protection National AER-O-FOAM provides. AER-O-FOAM forms a quick, thick, tough, airtight blanket of foam that snuffs out flames . . . protects production facilities, refineries and bulk plants. Non-corrosive, it can be washed or brushed off machinery, walls and floors when dry.

For positive fire protection, use FIRE-TESTED National AER-O-FOAM. For complete fire-fighting equipment and engineering assistance, call on National Foam Fire System Engineers.

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Serving the Petroleum Processing Industry

Expansion, Transition

Process Industries Engineers, Inc., has recently organized and opened offices in Pittsburgh. Company vice president is William W. Calihan, who recently resigned as Director of Sales and Advertising of the H. K. Porter Co., Inc. Other officials are R. R. Maccary, R. E. Nelson, and R. F. Fey. Plan is to integrate sale of established engineering equipment with design and fabrication of specially-designed equipment. Fields to be covered will include material storage, handling, fluid movement, mixing and agitation, reduction and separation.

Yarnall-Waring Co., Philadelphia, manufacturers of steam engineering equipment—valves, gages, columns, joints, traps, nozzles, strainers, etc. —has recently completed its 40th year of operation. Company magazine, YARWAY News, has devoted entire recent issue to a history of the company and its products.

Swift & Co. has made first delivery of product from its new industrial oil processing unit at the Technical Products Plant at Hammond, Indiana. Products from this new plant will provide raw materials to industries that manufacture such items as buffing and lubricating compounds, cutting oils, insecticides, candles, floor waxes and polish, etc.

American Steel & Wire Co., a subsidiary of United States Steel Corp., has set up a separate sales division for stainless steel wire, bars, and strip. Executives include Banks E. Eudy as manager and C. Richard Horwedel as assistant manager.

Combustion Engineering Co. and **Superheater Co.** have been merged following recent approval by stockholders of both concerns. New firm name is Combustion Engineering—Superheater, Inc.

Branches, Distributors

Airetool Manufacturing Co., Springfield, Ohio, has opened a new branch office in Tulsa, with James M. Brown in charge. Mr. Brown has been moved over from a similar post at the company's recently opened branch office at Baton Rouge, where he has been succeeded by M. E. Segraves. As manager of the Tulsa branch, Mr. Brown has been assigned to serve customers in Oklahoma, north and west Texas, eastern New Mexico, and will be available for service calls in Kansas.

Syntron Co. has established a new sales office in Des Moines, Iowa, with Mark Chisholm as district sales manager; and a new office in Kansas City, Mo., with Ernest K. Hood as district sales manager.

American Flexible Coupling Co. has appointed Ehret & Kinsey as representative sales engineers in Chicago, located at 327 So. La Salle St., Chicago 4.

Wheelco Instruments Co. announce the opening of a new district office at 2204 Fannin St., Houston 5, Texas. The new location, under the direction of George Hatfield, formerly of the company's Chicago sales office, will handle sales and service for the states of Texas, Louisiana, and New Mexico.

Personnel Changes

Thomas Bryan & Associates—A. C. Atwater has joined this industrial engineering and constructing firm as manager of the petroleum and chemical division at the main offices in Houston. Mr. Atwater has worked with Atlantic Refining Co. as a development engineer on cracking processes; Arthur G. McKee & Co., as process design engineer on refinery construction, and more recently in various capacities representing McKee on foreign refinery construction projects in Japan, Brazil, France, Italy, Germany, England, and Roumania.

Foster D. Snell, Inc. — John J. Mahoney has been named Director of Engineering, with headquarters at the company's building, 29 West 15th St., New York City. Mr. Mahoney, a graduate in chemical engineering in 1940 from the College of the City of New York, pursued further studies under a graduate fellowship at the University of Pennsylvania. He comes to the Snell organization following experience with Colgate-Palmolive-Peet Co., Burns & Roe, Selas Corp. of America, and the Philadelphia Navy Yard.

Taylor Forge & Pipe Works—Frank S. G. Williams, of New York, and eastern manager for Taylor, has been elected chairman of the American Standards Association Sectional Committee B-31, which is responsible for the American Standard Code for Pressure Piping.

Lima-Hamilton Corp.—Eugene C. Schum, formerly district sales manager of the Nordberg Manufacturing Co., has been appointed Diesel engine sales manager of the Hamilton Division, and will make his headquarters at Hamilton, Ohio.

Truscon Steel Co. — C. B. McGehee has returned to assume the responsibilities of his former position as General Manager of Sales, after a year's leave of absence.

Stainless Products, Inc.—Fred W. Duemler, formerly vice president of the Walworth Valve Co., has been named manager of Stainless Products' southwestern district, with headquarters at 309 Browder St., Dallas 1, Texas.

National Supply Co.—A. E. Witt has retired from active duty as Division Controller and Assistant Secretary, but will remain with the Torrance, Calif., group in an advisory capacity. He has completed 32 years of service with the company. Fred W. Mill comes from the position of General Plant Controller to Mr. Witt's position as Division Controller. Mr. Mill has been with the company since 1917, starting at that time as Timekeeper at Torrance.

United Centrifugal Pumps, a division of **United Iron Works**—Val Lobanoff has been appointed Assistant Chief Engineer at the main office and plant, Oakland, Calif. Mr. Lobanoff's previous specialized experience in refinery and high pressure boiler feed pump design has resulted in his being assigned to aid in developing new lines of centrifugal pumps.

Iverson Supply Co.—J. W. (Joe) McCarty has been named to the company's sales staff with headquarters at Tulsa in the general office. Mr. McCarty was associated previously with Franklin Supply Co., Bethlehem Supply Co., and Manning, Maxwell and Moore, Inc.

Allegheny Ludlum Steel Corp. — Robert M. Arnold, a director, has been appointed to the position of a newly created vice presidency. Mr.

Arnold is also president of Arnold Engineering Co., of Chicago, a wholly-owned subsidiary.

Bjorksten Research Laboratories—Mrs. Guitta Blau, who majored in chemistry at Columbia and Cornell Universities, has joined the staff of a newly established branch at Madison, Wis.

Joseph T. Ryerson & Son, Inc.—William Seymour, Jr., with the company for 31 years, has been elected vice president and will be in charge of plant operations and service for the entire group of 13 plants. C. L. Hardy, who joined Ryerson in 1927 at its Boston plant, has been elected assistant vice president and will serve in an executive capacity in the procurement branch. Thomas G. Miller, with the organization 11 years, has been moved up from assistant secretary to secretary.

R. G. LeTourneau, Inc.—Hans A. Bohuslav has been appointed special engineering consultant to President LeTourneau. Mr. Bohuslav comes from Engineering Controls, Inc., where he was vice president in charge of engineering and production. Born in Dresden in 1902, he received his technical training in German schools before coming to this country. He has served a number of companies as well as the armed forces in a consulting capacity on Diesel engine development.

American Brake Shoe Co. — Phillip H. Clapp, Jr., a sales representative, has been moved up as sales manager of the Engineered Castings Division, with headquarters at Rochester, N. Y.

Columbia Chemical Division, Pittsburgh Plate Glass Co.—Brooks M. Dyer, associated with the division since 1943, has been named St. Louis district sales manager, with headquarters at 3650 Market St., succeeding Vernon L. Clark, who has been assigned to special sales duties. Mr. Dyer served as assistant district sales manager at Philadelphia until his transfer to St. Louis.

Clark Bros., Inc. — Richard (Dick) Jenkins has been appointed to the Los Angeles office Technical Service Department, coming from the company's plant at Olean, N. Y.

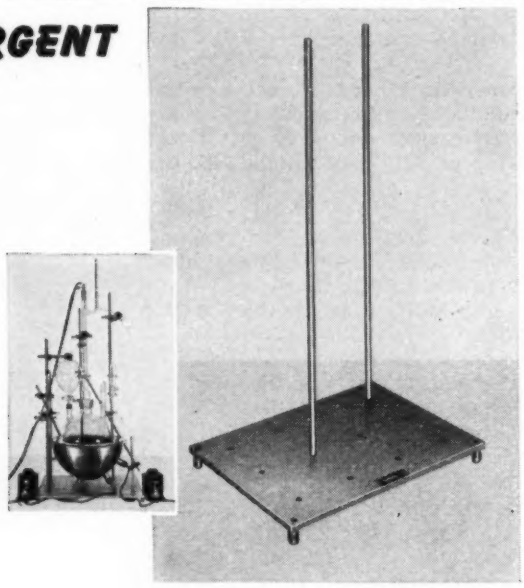
Ozark-Mahoning Co. — Dr. Wayne E. White, of that company, has been elected chairman of the Tulsa section of the American Chemical Society, succeeding Dr. Paul H. Cardwell, chief chemist of **Dowell, Inc.**, who in turn was named Section representative on the ACS National Council. Prior to his association with Ozark-Mahoning in 1946, Dr. White was professor of chemistry and physics at the American Institute, La Paz, Bolivia; a research chemist with Aluminum Co. of America; and a chemistry instructor at Western Reserve University.

American Mineral Spirits Co.—Clyde C. McInnes, formerly district manager of the Midwest and Southwest territory, has been appointed manager of the Extraction Solvents Division.

Great Lakes Carbon Corp. — Dr. Ernest R. Lilley has been elected vice president in charge of the company's Oil and Gas Division. For many years manager of the division, Dr. Lilley also continues as its chief geologist and makes his headquarters at the New York general office. A Guggenheim Fellow in 1930-31, he is the author of a number of books on the geology of oil and natural gas. During the war he served the Office of Petroleum Administration for War as chief analyst, division of reserves.

★ THE NEW SARGENT

ASSEMBLY SUPPORT SYSTEM



for:

- Strength
- Rigidity
- Stability
- Flexibility of Application

Recognizing the inconveniences which are encountered in using conventional type support stands for setting up assemblies in the laboratory, E. H. Sargent & Co. has devised a new assembly support system which eliminates these difficulties and provides the chemist with a highly useful base on which to carry out any bench operation.

Consisting of a heavy gauge aluminum plate, available in two sizes, supported by four adjustable feet, for leveling, and tapped and threaded at convenient intervals to receive stainless steel rods, this new support stand has qualities of stability, rigidity and flexibility of application not found in other conventional type stands.

The stainless steel rods are threaded at one end and tapped at the other, giving the operator a variety of heights in one foot increments as well as a wide selection of lateral distances at which the rods may be placed. For setups having large lateral distances two or more of these bases may be locked together by crossbracing an upright on one to an upright on another. Any conventional clampholder of sufficient size to fit the rods will work satisfactorily.

The new Sargent Assembly Support System offers a common level base with heavy steel rods on which a wide variety of assemblies may be constructed and held rigidly in place.

For your convenience in preparing an initial order, we have grouped under the following catalog numbers, such of the component parts of the system as we believe will be adequate for general laboratory use:

S-78390 consisting of one, No. 78370 large aluminum plate 24"x16"x⅛"; four, No. 78374 leveling feet; three, No. 78380 stainless steel rods 36"x⅝"; two, No. 78383 stainless steel rods 12"x⅝"..**$36.25**

S-78391consisting of one, No. 78372 small aluminum plate 16"x12"x⅛"; four, No. 78374 leveling feet; three, No. 78381 stainless steel rods 28"x½"; two, No. 78382 stainless steel rods 12"x½"..**$23.50**

Separate Bases, Feet and Rods are also available—write for our Bulletin on The New Sargent Assembly Support System.

SARGENT

SCIENTIFIC LABORATORY EQUIPMENT AND CHEMICALS

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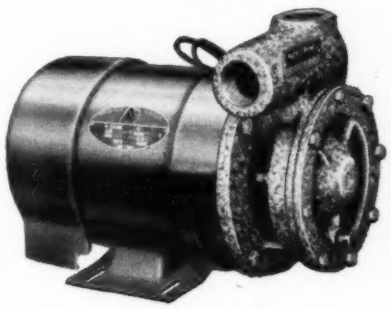
SOUTHWESTERN DIVISION 3915 PEELER ST. DALLAS 9, TEXAS

What's New!

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

Reviewed by WILLIAM C. UHL, Equipment Editor

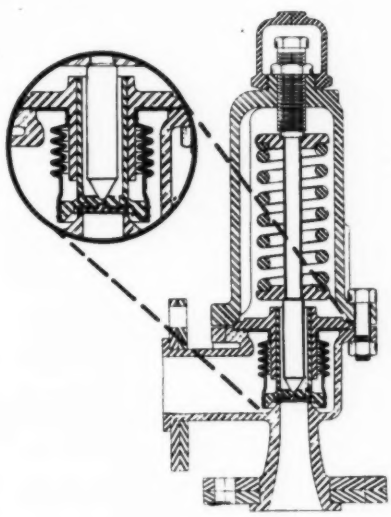
1—Low Capacity Turbine Pump



With motor and pump combined into one assembly, the "Monobilt" turbine type pumping unit is designed to meet small floor space requirements in a small capacity pump, ranging from 2 to 10 gpm. Pumps are available in three standard constructions: bronze-fitted, all iron, and all bronze. Motor is single phase, 110-220 volt, 60-cycle capacitor type, with ball bearings, and stainless steel shaft. All motors except ¼ hp. are dual voltage: the ¼ hp. is 110 volt only. Roy E. Roth Co.

2—Improved Safety Valve

The "FarriSeal Bellows" is a type of construction for safety valves that isolates completely the lading fluid from the valve spring chamber and guide surfaces, and is said to be of advantage in connection with back pressure surge applications involving corrosive fluids. In such applications normally, the surges cause the valve to pop early or late. With the FarriSeal Bellows, complete graphs are furnished allowing the user to predetermine the point at which the valve is to be set in order to eliminate the error of back pressure surge. The device itself is an enveloping bellows built into the valve. It is made in type 316 Stainless steel as standard, and is available also in rubber and neoprene. It is reported to operate satisfactorily in cases where back pressures have been as high as 150 psi. Farris Engineering Corp.

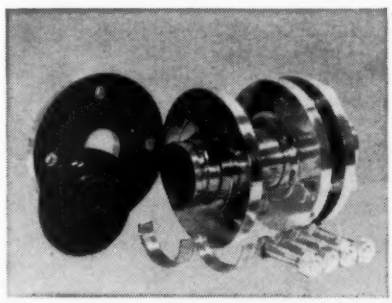


3—Air Compressor Motor

E-M "Design X" is a new line of low starting kva, squirrel cage induction motors, in flange-mounted type and coupled two-bearing type, for direct connection to 514, 600, and 720 rpm, air compressors. Maker states the design permits full-voltage starting (across-the-line) with a starting kva. of 425% as compared with 550% on NEMA Design B motors. Advantage of full voltage starting is requirement for simpler, lower cost control equipment. Motors are available in hp. ratings of 60, 75, 100, 125, 150, 200, and 250. Electric Machinery Mfg. Co.

4—Joint for Lined Pipe

The "Gaco" joint is reported to reduce installation and repair costs on rubber-lined pipe as much as 50%. Manufacturer states it eliminates three steps normally encountered in lined pipe installations: no detailed layout plans are needed; welded fittings are eliminated; and repairs can be made on the spot by plant maintenance crews if a supply of joints are kept in stock. Gaco joints are supplied in ½ to 4-in. pipe sizes as 45° and 90° ells, Y's, Tees, and separate flange kits for connecting straight lengths. Gates Engineering Co.



More "What's New!" Items, p. 194

For More Information

Use one of the attached reply cards to request additional information or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the rest of the card, and drop it in the mail. No postage required.

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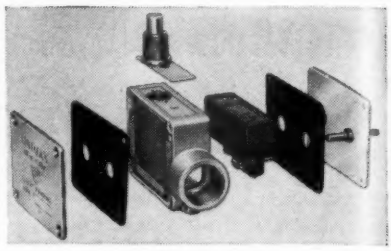
WORK-SAVER PIPE TOOLS

THE RIDGE TOOL CO. • ELYRIA, OHIO

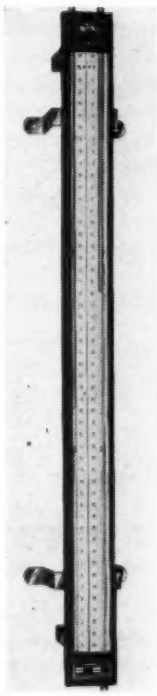
What's New!

5—Protected Switch



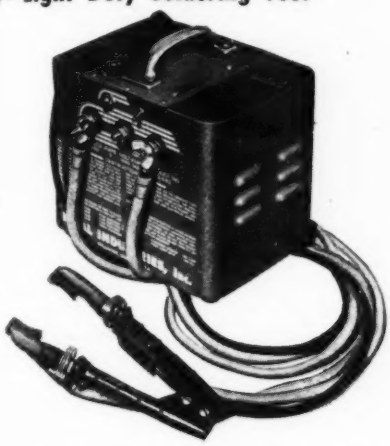
A die-cast and neoprene gasketed, aluminum housing totally encloses the "Unimax" Model KMX precision switch, affording sealed protection for the switch itself against splashing oil, moisture, and abrasives. Simplified mounting is provided by means of slip fit pins, interchangeable side-plates, etc. Conduit hub connection has an internal ½-in. pipe thread. Overall dimensions of the aluminum housing are 1-13/16 in. high, 2¼ in. wide, 7/8 in. deep. A stainless steel pin on top the housing transmits the operating force to the inner basic switch element. Unimax Switch Division, W. L. Maxson Corp.

6—Calibrating Manometer



The Dual-Tube, Meriam Model-100 Manometer is expected to have a wide application in the petroleum refining field. It consists of two separate manometer tubes in the same case, each tube with an individual well. The design enables an operator to read high range pressures, vacuums, and differentials from the floor level. The tube on the left has a scale increasing upward; the one on the right a scale increasing downward. Both tubes are connected in parallel to the same pressure source. The instrument is available in ranges from 50 to 150 in. Direct reading, it is useful as a calibrating standard for flow meters, pressure gages and other units operating on pressure or vacuum principle. Meriam Instrument Co.

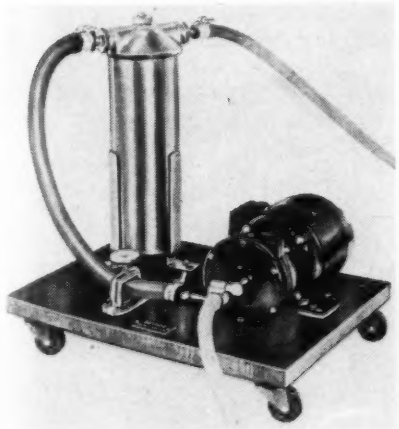
7—Light Duty Soldering Tool



The Ideal 450-watt "Thermo-Grip" is a light duty soldering tool operating on the resistance heating principle and adapted to intermediate requirements such as small motors, switchboards, tubing, and other electrical equipment. Accessories include a "pliers" attachment, "fork" attachment, and "pencil" attachment, each with plastic handles. The power unit and carrying case of the tool measures 9½ x 6 x 8¾ in., including storage space for the attachments, and weighs 16 lbs. complete. Two heats are provided, 5.3 and 4.2 volts. Ideal Industries, Inc.

8—Stainless Filter Pump

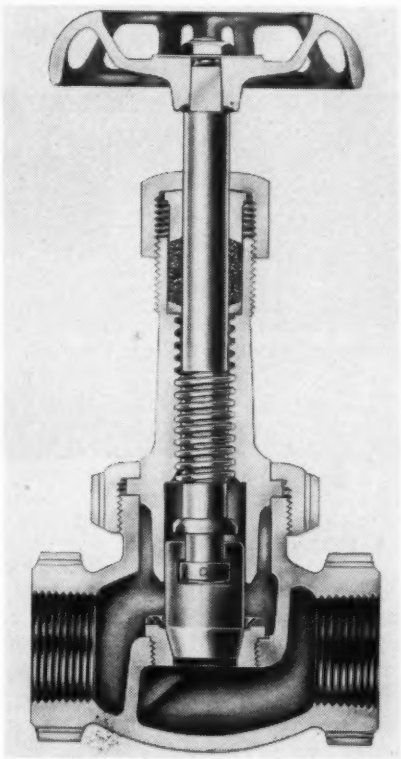
"SETHCO" Model SSI Filter Pump Unit, made entirely of Type 316 stainless steel, uses granular activated charcoal in a filter tube made of processed cotton yarn wound around a stainless steel core. It is said to require no filter aid to remove even colloidal particles. Greatest efficiency is obtained at a filtration rate of 100 gals./hr.; however, rates as high as 250 gph. can be handled. The unit comes complete with 110 volt AC or DC motor, pump, and filter, mounted on a laminated plastic panel, and weighs 40 lbs. Four casters provide ready mobility. Sethco.



9—Hexadecane Available

Research quantities are now available of hexadecane, a moderately priced olefin raw material which is reported to have interesting possibilities in organic syntheses. Some of its physical properties are: 242° C., boiling point; less than −50° C., pour point; 90° C., flash point. Viscosity range is: 3.57 centistokes at 38° C.; 2.57 at 54° C.; and 1.33 at 99° C. Houdry Process Corp.

10—Close Throttle Valve



Designed for close throttle service, the Fig. 976-A, Jenkins, plug type, bronze, globe valve is said to be especially suited for pressure regulation, steam control by-pass lines, temperature regulation, bleeds, drips and drains, soot blowers, continuous blowdowns, or any close control of steam. A 300 psi. valve, it is available in sizes ¼ to 2 in., and has a plug and seat ring of a heat-treated, stainless steel of 500 Brinell hardness. A long thread on the spindle (15.9/in.) permits 9 threads to be in contact at all times, providing less load per thread and long wear. Jenkins Bros.

More "What's New!" Items, p. 196

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STOP WATCHES
You will find our new catalog most useful. It describes and illustrates a complete line of timers for all laboratory and industrial needs . . . including special timers for specific purposes.
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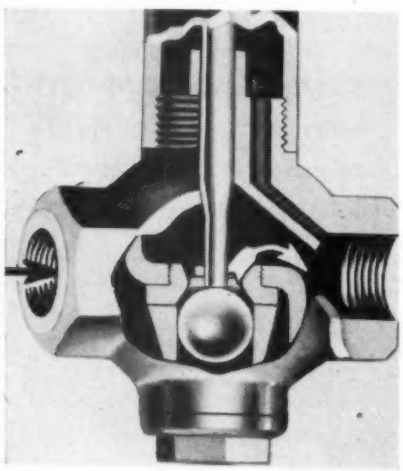
11—Lightweight Dust Hood

The "G-S" Fabric Dust Hood is loose-fitting and weighs only five ounces. Complete visibility is provided through a large, clear plastic window. The unit can be worn with goggles or a respirator, and is applicable to such operations as cleaning boilers, furnaces, or wherever dust, dirt and spray is a nuisance. General Scientific Equipment Co.

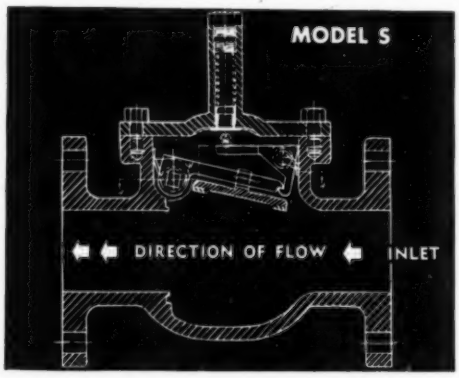
12—Ball-type Inner Valve

Accurate regulation, greater capacity, and tight closing are said to be features of the new ball type inner valve construction now supplied in all valves of the Klipfel "400" Series; for applications in steam, water, air, or gas service at inlet pressures less than 250 psi., reduced pressures below 150 psi., and where the reduced pressure must be adjusted frequently. The inner valve is actuated by a rubber diaphragm, the ball centering freely on the seat with uniform contact. When off the seat the ball is free to rotate so that all parts are exposed in turn to the scouring action of the flow; thus wear is in time evenly distributed. Klipfel Mfg. Co., Division of Hamilton-Thomas Corp.



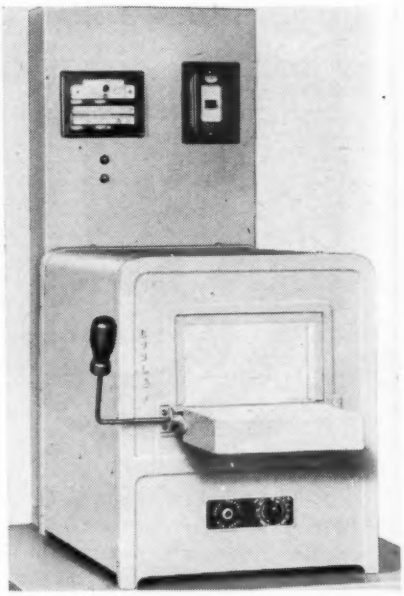
13—Low-pressure Shut-Off

The "Warden" Automatic Low Pressure Shut-off Valves use a precision lapped synthetic rubber seat and are recommended for gas or fluid lines where positive closure is desired when pressure fails from any cause. They are said to be easily installed on gas or oil lines for industrial furnaces and the like; they must be reset manually after closure. Valves are set to close at pressure specified by a customer and are available in Model S, shown above, for high pressure use (4 oz. to 150 psi.) and Model G, for low pressure use (down to 2 in. water). Currently furnished in sizes from ¾ through 8 in. Security Valve Co.



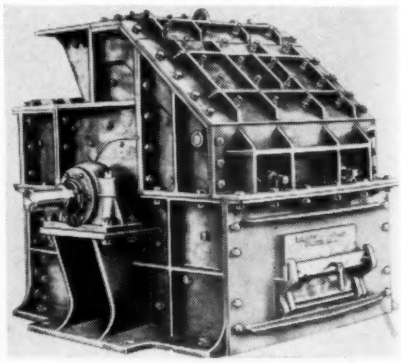
14—Laboratory Furnace

The Type MM Cooley laboratory muffle furnaces are designed for an overall temperature range from 300 to 2000° F. through use of an improved control mechanism which is said to extend the normal limits of about 1200° F. usually encountered in conventional rheostat-controlled furnaces. The control unit, called a "Selective Power Modifier", is essentially a synchronous motor-driven variable cam which operates an ON and OFF switch once each minute. The only power consumption is in the motor drive. The cam position, controlled by a setting knob, permits varying the ON and OFF intervals so that any power input from 5% to full power can be obtained. Control is thus obtainable from about 300 to 2000° F., or furnace maximum. Five models of the Type MM line are offered, with inside dimensions from 4 x 3 x 8 in. to 10 x 6 x 18 in. Temperature uniformity of +5 −0° F. is maintained by the power modifier used in conjunction with an indicating-controlling pyrometer. Power input is 4 kw. at 230 volts. Cooley Electric Mfg. Corp.

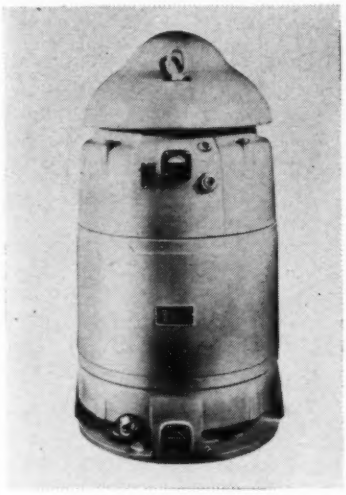


15—Oil-shale Crusher

The "ACS" Hammermill Crusher, designed to reduce any hardness of friable materials uniformly and at a high tonnage rate, is reported to be proving efficient for oil shale reduction purposes. Capacity of the unit is 250 tons of oil shale per hour. All crushing parts are of manganese steel, with joints machined for dust-tightness. Three types of hammers permit flexibility in reduction action to fit specific operating demands. Hammers are reversible, with two crushing surfaces. Replaceable grate bars are reinforced for added strength and are closely fitted for accurate control of product size. The "ACS" mill is available with either a conventional front feed for coarse product, or a specially designed center feed which lengthens the travel of shale in the crushing cycle for finer product and more rapid reduction. American Pulverizer Co.



16—Deep Well Pump Motor



The "Verticlosed Streamway" Motor, for deep well vertical pumps, has an interchangeable base to permit increase or decrease in horsepower without re-machining or exchanging the pump head. A waterproof housing protects vital parts of the motor. Downdraft ventilation blasts hot air for approximately five diameters away from the motor. An adjustable hollow shaft makes it possible to adjust precisely the pump impellers and permits the heavy thrust bearing to be placed on top, eliminating the necessity of using a flexible coupling between motor and pump shaft. Standard models include a reverse protection clutch: a special non-reversing locking device is optional. U. S. Electrical Motors, Inc.

17—Oil-resistant Rubbers

A series of synthetic rubber compounds, Buna N, Hycar, or Neoprene-based, are now available for fabrication into gaskets, sleeves, washers, tubing, and molded and extruded products designed to resist the chemical action of petroleum products, their derivatives, and other industrial or commercial lubricants. Synthetic rubbers having tensile strength from 500 to 2500 psi. and elongations from 100 to 600% can be supplied according to specifications. Manufacturer states the rubbers can withstand temperatures ranging from —60 to 225° F. Stalwart Rubber Co.

18—Floor Protection

"RESN-X" Flooring is a new resilient and durable resurfacing material for floors which it is claimed will remain unaffected by most acids, alkalis, oils, fats, and the like. It is non-slip, a good electrical insulator, and is recommended also as a safety stair tread. The material comes ready-mixed, packaged in 6-gal. containers, and in three standard colors: tile red, utility green, and medium gray. Coverage per gallon is approximately 60 sq. ft., at 1/32 in., and 30 sq. ft. at 1/16 in. thickness. Floors can be walked on in six hours. Full traffic can be resumed in 24 hours. Rock-Tred Corp.

Trade Literature

19—Laboratory Instrumentation

Instrumentation, Vol. 3, No. 5; includes article describing instrumentation of both research and service facilities at the new Whiting Laboratories of Standard Oil Co. (Indiana). The Brown Instrument Co.

20—Petroleum Processing Index

Petroleum Processing Index for 1948; covers all special articles and stories as well as all regular departmental features for the 12 issues of the past year. Classification by subject and by author, completely cross-referenced for ease of use. National Petroleum Publishing Co.

21—Walkways & Loading Racks

Safwalk Walkways and Loading Racks, Part 1, Sect. 6, Catalog 54; a 42-page booklet giving complete description of equipment for assembling refinery or bulk plant walkways, loading racks, etc., including dimensioned drawings, specifications, and application photographs. Black, Sivalls & Bryson, Inc.

22—Valve Performance Report

Performance Report on Sellers Positive Shut-off Valve for Highly Corrosive Penetrative Fluids; Report No. 94; gives performance data on 1200 valves and detailed data on 23 of them in service over five years, handling hydrocarbons, hydrofluoric acid, caustic soda, sulfuric acid, free sulfur, etc. at temperatures from 75 to 300° F. and pressures from 20 in. Hg. vac. to 320 psig. Sellers Injector Corp.

More "What's New!" Items, p. 199

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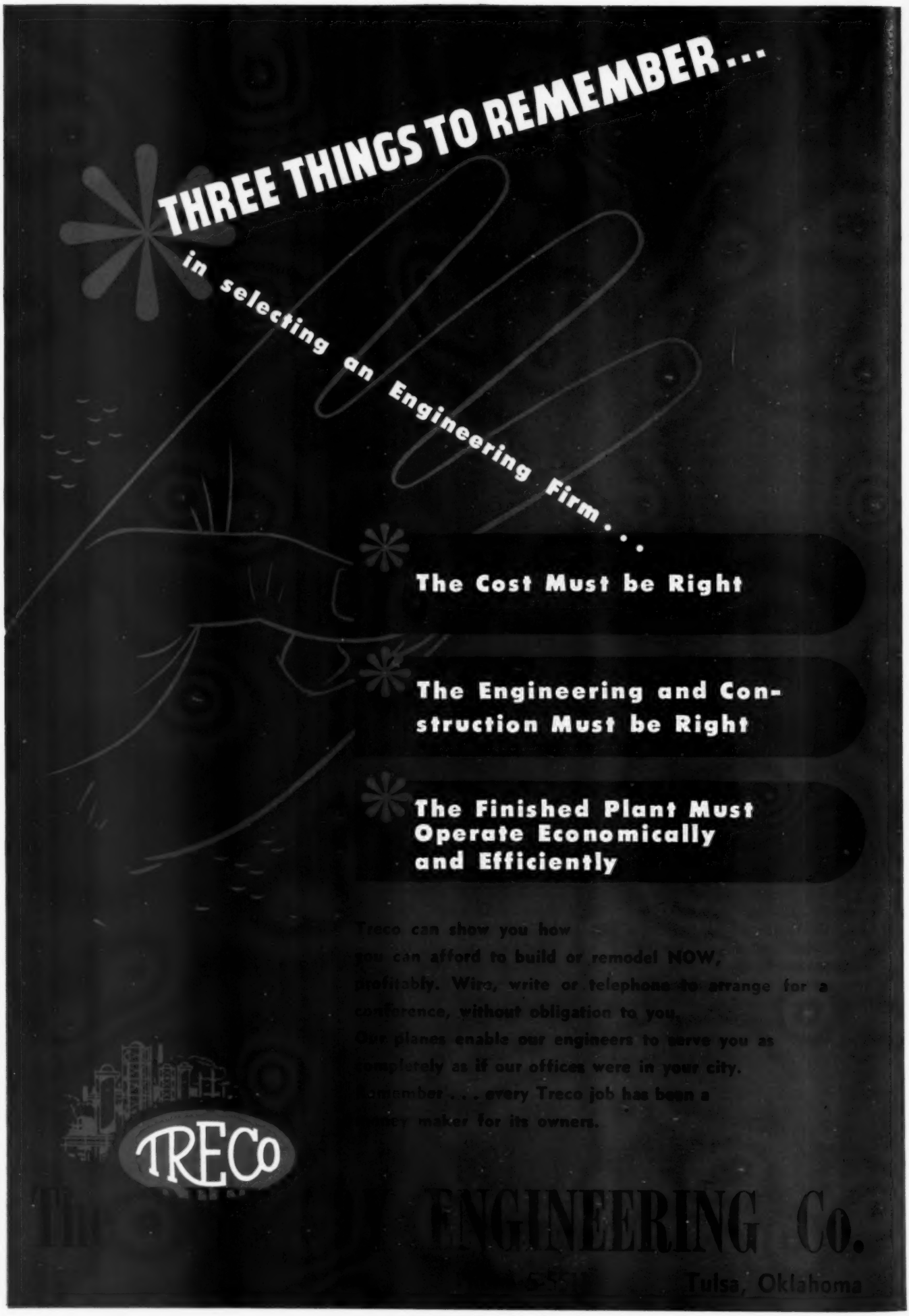
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What's New!

23—Non-fouling Exchangers

The G-R Type CW Tubeflo Section, Bulletin 1622: explains design of heat exchanger in which heavy, viscous, or sediment-bearing liquids are carried through without fouling; including a chart for solving mean temperature difference formulas. Griscom-Russell Co.

24—Electric Desalting

Petreco Electric Desalting; a 12 page booklet explaining the electrical method for desalting crude oil, with charts showing operational effects on charge rate, furnace temperatures, pre-heater performance, and salt content of crude; including case histories. Petroleum Rectifying Co.

25—Petroleum Hydrocarbons

Phillips 66 Hydrocarbons, 3rd Edition; and *Price List No. 7*; catalogs complete line of hydrocarbons and aliphatic sulfur chemicals presently available; and brings up to date, as of January 1, 1949, charges, conditions of sale, shipping data, and other information. Phillips Petroleum Co.

26—Boiler Surface Coatings

Apexior Number 1, Bulletin 1530; describes a new protective coating for steam and boiler water exposed surfaces in boilers, economizers, circulators, and reheat units. The material is said to afford complete protection of metal at any degree of wet heat from 200° F. to highest operating temperatures encountered. Dampney Co. of America.

27—Steam Turbine Centrifugals

Coffin Turbo Pumps, Bulletin No. 5; gives specifications and sectional drawings on a line of high speed, single-stage, steam turbine driven centrifugal pumps with the following maximum ratings: steam pressure to 850 psi., back pressure to 200 psi., capacity to 500 gpm., discharge to 1100 psi., head to 2500 ft., and liquid temperature to 300° F. J. S. Coffin, Jr., Co.

28—Petroleum Products Pump

Marlow Self-priming Centrifugal Petroleum Product Pumps, Bulletin PM48; 12 pages of engineering data, charts, and the like compiled during the development of a new centrifugal pump with self-priming and self-purging action, which is available in capacities from 15 to 2000 gpm. Marlow Pumps.

More "What's New!" Items, p. 200

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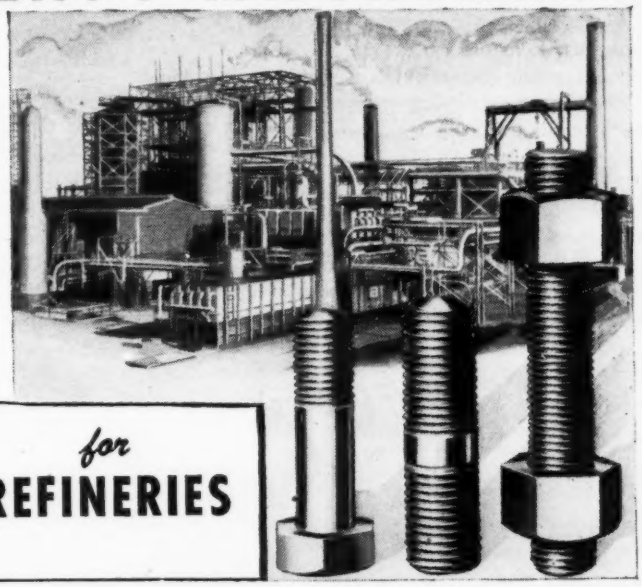

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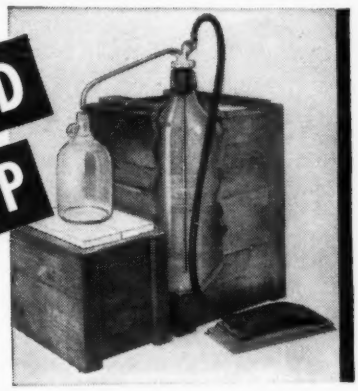

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29—Packing Materials

Packing for the Chemical Industry; an 8-page bulletin giving specifications, applications, and special features of a line of packings for chemical use, including coils, spools, sheets, etc. Crane Packing Co.

30—Hydrofluoric Acid

Hydrofluoric Acid Anhydrous; 36 pages on this material, including physical properties, types and materials of construction for equipment used, methods of handling and storage, sampling and analysis, and a description of its use in the alkylation of isoparaffins with olefins, as a condensing agent, and as a fluorinating agent. Harshaw Chemical Co.

31—Chlorine Safety Chart

Recommendations for Safety in Use and Handling of Liquid Chlorine Cylinders and Ton Containers; an 18 x 23 in. wall chart in color on linen backed paper, lists recommendations for storage, handling, and use of chlorine containers, as well as emergency, first aid, and prophylactic measures. Hooker Electrochemical Co.

32—Corrosives-handling Pumps

Model 40 Corrosion Resisting Series M Durcopumps, Bulletin 815; 20 pages with sectional drawings, cutaway views, and specifications on a centrifugal pump line with interchangeable parts, available in 12 corrosion-resistant alloys, and with Teflon seal cages. Duriron Co.

33—Thermocouples

Thermocouples and Pyrometer Accessories, Bulletin No. P1238; 56 pages of catalog information, engineering handbook data, and typical applications on thermocouples, protection tubes, and the like, including calibration tables and other information helpful to the user. Bristol Co.

34—Helium-shielded Welding

How to Use Helium-Shielded Arc Welding, a reprint of an article by Harold O. Jones, of technical sales division, Air Reduction; originally published in the *American Machinist;* describing the technique, equipment used, and citing case histories of its application. Air Reduction Sales Co.

35—Industrial Research

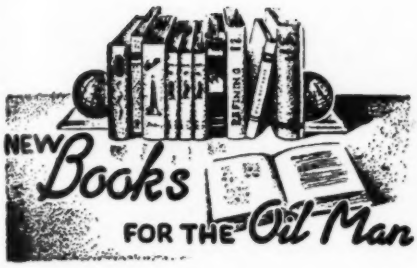
Partners in Research is the 44-page Annual Report, 1948, of the Armour Research Foundation of Illinois Institute of Technology, covering in interesting description most of the important projects being executed by the Foundation, including many of interest to the petroleum processing industry.

36—Small-size Filters

Laboratory and Pilot Plant Filters, Bulletin No. 251-R; a four page leaflet describing a line of filters, continuous filters, and filter presses useful in experimental and control work. Oliver United Filters Inc.

For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 192. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.



Mines Bureau Issues Report On Synthetic Liquid Fuels

Synthetic Liquid Fuels from Hydrogenation of Carbon Monoxide, Technical Paper 709, Part 1; Bureau of Mines, by Henry H. Storch, R. B. Anderson, L. J. E. Hofer, C. O. Hawk, H. C. Anderson, and N. Golumbic; 5¾ x 9 in., 220 pages, no cover binding, illustrated, indexed. (1948). 50c. Order direct from Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D. C.

This first part of the Mines Bureau's report on *Liquid Fuels from Hydrogenation of Carbon Monoxide* is divided into three major sections and an appendix. The first section, a review of the literature, covers the period 1913-1932 briefly in the introduction. Then it goes into industrial and engineering developments in the Fischer-Tropsch synthesis, the various catalysts used, the effects of operating conditions on the process, the properties of synthesis products, and estimates of costs.

The second section is on the Mines Bureau's research on catalyst preparation. The third deals with the correlation of physical properties of Fischer-Tropsch catalysts with their activity. An appendix presents procedures for the preparation of the various catalysts discussed in the main text. A well executed index is divided into three classifications: patents, listed numerically; authors; and subject matter.

In general it is an excellent piece of work that Dr. Storch and his associates have here produced. Considering the wealth of data being published every day on this fundamentally important topic, it is indeed well that at least much of the earlier work, prior to about 1946, has been consolidated and ably presented in this volume.

Chemical Corps Story Related In New Non-technical Book

The Chemical Warfare Service in World War II; 6 x 9 in., 226 pages, stiff cloth binding, illustrated, $4.00. (1948).

Technical men in the petroleum industry who may be presently reserve officers in the military, or who may be active in any future armed conflict, will find much of interest in *The Chemical Warfare Service in World War II.*

A report of the accomplishments of that part of the armed forces now know as the Chemical Corps, this book has been prepared under the sponsorship of the Chemical Corps Association as a result of numerous requests for data on chemical warfare activities during the recent war.

It is by no means complete and is said to be at most a comparatively non-technical report offered as a preliminary source of information to an official history, which will be provided eventually by the department of the Army in its complete history of World War II. Subjects covered include training of personnel, gas warfare, chemical mortars, smoke protective screens, flame throwers, incendiary bombs, and special problems such as the use of insecticides and the like.

The Chemical Corps Association, now about four years old, is composed of regular and former officers and men of the chemical organization as well as civilians engaged in chemical warfare services. Although the association had access to most of the records, the preface points out that time and funds placed a limitation on the extent to which the book could be complete.

Book review briefs

Design for Welding, edited by R. S. Green, D. C. Williams, and C. B. Smith; 5¾ x 8½ in., 1054 pages, flexible binding, illustrated, indexed, $2.00. (1948) A compilation of the 82 prize-winning papers in the most recent James F. Lincoln Arc Welding Foundation Awards. Order direct from the Foundation, Cleveland 1, Ohio.

High-Polymer Physics, A Symposium, edited by Howard A. Robinson; 5½ x 8½ in., 572 pages, stiff cloth binding, illustrated, indexed, $12.00. (1948)

Scientific and Technical Abbreviations, Signs and Symbols, by O. T. Zimmerman and Irvin Lavine; 5½ x 8¼ in., 488 pages, stiff cloth binding, $7.50. (1948)

Handbook of Material Trade Names, by O. T. Zimmerman and Irvin Lavine; 5¾ x 9 in., 515 pages, stiff cloth binding, $8.00.

Mechanical Behavior of High Polymers, by Turner Alfrey, Jr.; 6 x 9 in., 595 pages, illustrated, indexed, stiff cloth binding, $9.50. (1948)

Unless otherwise indicated, copies of all books reviewed here may be ordered from the Reader's Service Department, Petroleum Processing, 1213 West Third Street, Cleveland 13, Ohio, for the price listed, postpaid. Ohio purchasers please add 3% tax. NOTE: publisher's prices are subject to change without notice.

MEETINGS . . . for the Oil Man

FEBRUARY

10, Chemical Market Research Assn., Biltmore Hotel, New York.
28-Mar. 4, American Society for Testing Materials, Spring Meeting and Committee Week, Hotel Edgewater Beach, Chicago.

MARCH

27-Apr. 1, American Chemical Society, 115th National Meeting (headquarters for Division of Petroleum Chemistry, Mark Hopkins Hotel), San Francisco.
28-30, Western Petroleum Refiners Assn., Plaza Hotel, San Antonio, Texas.

APRIL

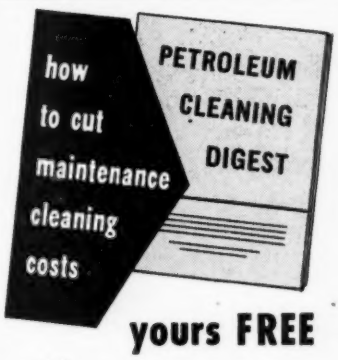
4-7, American Petroleum Institute, Division of Refining, Shamrock Hotel, Houston.
11-13, American Society of Lubrication Engineers, Hotel Statler, New York.
11-14, National Assn. of Corrosion Engineers, 5th Annual Conference and Exhibition, Netherlands-Plaza Hotel, Cincinnati, Ohio.
13-15, National Petroleum Assn., Hotel Cleveland, Cleveland.
20-22, Natural Gasoline Assn. of America, Texas Hotel, Ft. Worth, Texas.

MAY

9-11, Liquefied Petroleum Gas Assn., Meeting and Trade Show, Palmer House, Chicago.
12-13, Instrument Society of America, 4th Annual Spring Meeting, Royal York Hotel, Toronto, Canada.

JUNE

5-10, Society of Automotive Engineers, Summer Meeting, French Lick Springs Hotel, French Lick, Ind.
9, Chemical Market Research Assn., Annual Business Meeting, Biltmore Hotel, New York.
27-July 1, American Society for Testing Materials, 52nd Annual Meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.



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Personals

Stanwood W. Sparrow, president for 1949 of the Society of Automotive Engineers, is vice president in charge of engineering, Studebaker Corp., South Bend, Ind. A native of Massachusetts, he graduated from Worcester Polytechnic Institute in 1911 and immediately went to work for an automobile manufacturer. During World War I he was with the National Bureau of Standards on aircraft engine projects. He joined Studebaker in 1927 as research engineer and was in charge of building Wright Cyclone engines during World War II.

Mr. Sparrow

* * *

L. W. Moore has been elected president of Pan American Refining Corp. and Mexican Petroleum Corp. of Georgia and will have charge of the companies' refining activities. After graduating from Massachusetts Institute of Technology in 1933 he started in the research department of Standard Oil Co. (Indiana) at Whiting and in 1935 joined Pan American Petroleum & Transport. In 1945 he was made manager of research for Pan American Refining and in 1947 he was made manager of manufacturing and a director of this company and a director of affiliated companies.

Mr. Moore

D. J. Smith, while resigning as president of Pan American Refining and Mexican Petroleum Corp., remains chairman of the board and he is also president of Pan American Petroleum & Transport Co.

* * *

Dr. J. L. Franklin, Humble Oil & Refining Co. is the new chairman of the South Texas Section of the American Institute of Chemical Engineers. **Dr. W. A. Cunningham,** department of chemical engineering, University of Texas, is chairman-elect.

E. Duer Reeves, a vice president and director of Standard Oil Development Co. since 1947, has been elected executive vice president. A native of New York City, he is a graduate of Williams College and took graduate work in chemistry at Princeton.

Mr. Reeves

Mr. Gohr

He joined a company affiliate at Baton Rouge in 1931 and was transferred to the Development Company in 1937. In 1945 he became director of the Reearch division of Esso Laboratories. Mr. Reeves took an active part in the first experiments which resulted in the development of the modern Fluid catalyst cracking plants.

Edwin J. Gohr becomes a vice-president and director of Standard Oil Development Co. He has been assistant manager of its research and development department since 1945. He was born in Rochester, N. Y., attended the University of Rochester and graduated from Massachusetts Institute of Technology in 1926 with a degree in chemical engineering. He began his company service in process development work at Baton Rouge, was transferred to New York and in 1936 became assistant manager of the deveopment division. He aided in designing the first Fluid catalyst cracking unit.

* * *

E. J. Yocom, superintendent at the South Jennings recycling plant, Jennings, La., of Stanolind Oil and Gas Co. has been transferred to the Hastings gasoline plant, Alvin, Texas. He succeeds **C. W. Ward,** who has been made superintendent of Stanolind's new Elk Basin plant, Powell, Wyo. Mr. Yocom has been with Stanolind since 1933, and served as plant chemist and plant foreman at the South Jennings plant before being made superintendent. He has a B.S. degree in chemical engineering from the University of Illinois, and

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Hooker Aluminum Chloride is being used as a catalyst in many Friedel-Crafts syntheses, polymerization, isomerization and halogenation. Practically free from iron (0.05% max.) it is especially desirable in the preparation of derivatives for use in the manufacture of high octane gasoline, lubricants, synthetic rubber, dyes, varnishes and pharmaceuticals.

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Hooker Aluminum Chloride, Anhydrous $AlCl_3$
Gray, crystalline solid in four sizes.
Molecular Weight 133.3

ANALYSIS

Aluminum Chloride	98.5 % min.
Iron	0.05% max.
Sublimables in air at 950° C.	98.5 % min.

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The next stop for this CB&I-built reflux drum was Baton Rouge, La., where it went to work in one of the world's largest refineries—operated by Esso Standard Oil Company. The drum, which is 7 ft. 6 in. in diam. by 20 ft., is monel-clad for corrosion resistance, and is used as a reflux accumulator on an atmospheric pipe still. It operates at a maximum pressure of 50 lbs. per sq. in. at 650° F.

Our complete design and fabrication facilities are producing a variety of similar "custom-made" steel plate equipment for the petroleum industry: special designs and metals, high pressure and high temperature ratings—all are a part of our regular working specifications. We'll be glad to give you quotations on the steel plate vessels you need. Also on field-erected steel storage tanks. Ask our nearest office for details.

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Whessoe, Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland

also studied at University of Kansas and University of Wyoming.

H. W. Jones, plant foreman at Superior refinery, Vivian, La., has been made superintendent at the South Jennings plant, succeeding Mr. Yocom. He holds a B.S. degree in chemical engineering from Iowa State College and joined Stanolind in 1938.

* * *

Charles M. Ridgway Jan. 1 assumed the newly created position of manager of the Pure Oil Co. Research and Development Laboratories. A native of Titusville, Pa., he graduated from the University of Michigan and became superintendent of the Pure refinery at Midland, Mich. in 1932. Subsequently he was assistant superintendent at Pure's Heath, O., refinery and of its former refinery at Muskogee, Okla. He served with PAW during the war as Chief of the Economic Section of the Refining Division. Recently he has been technical assistant for Pure's refining division.

Mr. Ridgway

William B. Ross continues as director of research and development for Pure Oil Co. The company is building a new research center at Crystal Lake, Ill.

* * *

J. W. Sandberg is a process engineer in the Perco Division, Chemical Products Department, Phillips Petroleum Co., Bartlesville. A graduate of McGill University, Montreal, in 1940 in chemical engineering, he is a former member of the Engineering Institute of Canada and comes to this country after spending 6 years in Trinidad, B.W.I., at the refinery of Trinidad Leaseholds, Ltd.

Mr. Sandberg

* * *

Osgood V. Tracy is manager of the Chemical Products Department of Esso Standard Oil Co. He has been assistant manager. A graduate of the U. S. Naval Academy in 1924, he has been closely associated with the development of synthetic rubbers, alcohols and other chemical products from petroleum since he joined the company in 1930. He had previously served as division head of Standard Oil Development Co. and as manufacturing coordinator of chemical products for Esso Standard. He continues as a director of Enjay Co., Inc.

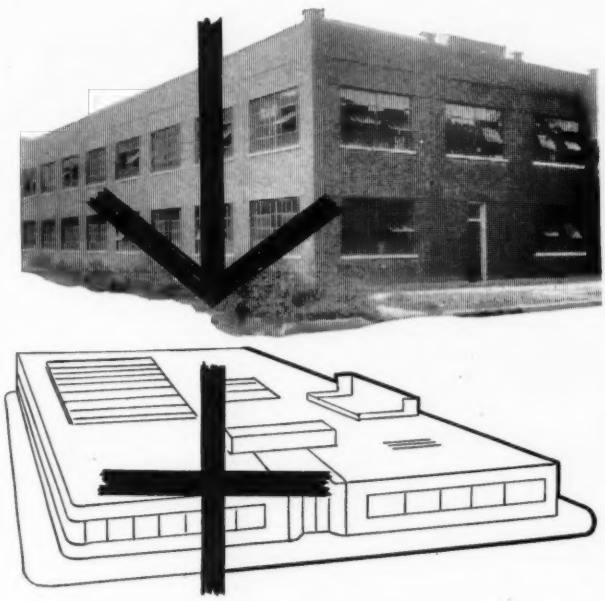
* * *

C. W. Walker is a maintenance foreman in the gas department of General Petroleum Corp., Lebec, Cal. He joined the company in 1928, served as pipefitter and sub-foreman and was made pipefitter leadman in the Lebec refinery in 1945.

J. T. Deane is vice president of Oronite Chemical Co. of Standard Oil Co. of California. He comes from the Oak Point, La., plant of the California Oil Co., where he was vice president and manager in charge of manufacturing lubricating oil additives.

* * *

V. E. O'Donnell, plant foreman at Stanolind's La Rosa recycling plant, Woodsboro, Texas, has been promoted to superintendent of the Luby gasoline plant, Bishop, Texas, succeeding **H. J. Olinger,** who was killed in a recent automobile accident. Mr. O'Donnell was plant engineer at the



The direction of plus-

A summary of achievement

How like the founding fathers' enigmatic words, "pursuit of happiness" is the "direction of plus." Surely there's no grand road to either. Yet this phrase seems to sum up Precision's record for the manufacture of scientific laboratory apparatus.

Note the photo above. It's a picture of our 1910 plant. It was adequate. We made good products there—mighty good. But, obviously, our newest and present plant is finer, better lighted, more modern.

It was the comparison between our plants which caused us to review, in retrospect, all of our products. How much better they are NOW than formerly. And how many different industries, scientific groups and associations, working in intimate collaboration with us, have contributed to that betterment—are now, continuing to improve today's products.

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Precision Scientific Company
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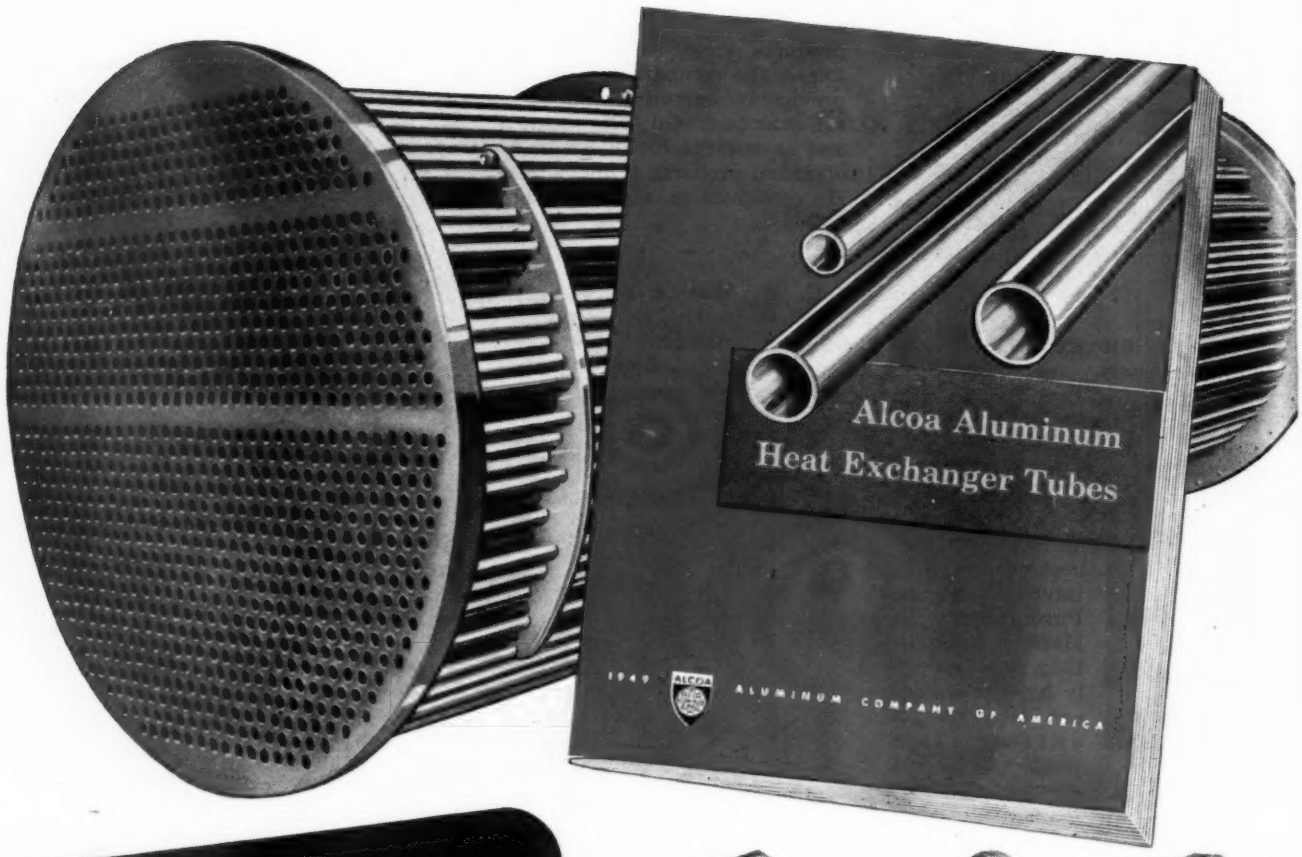
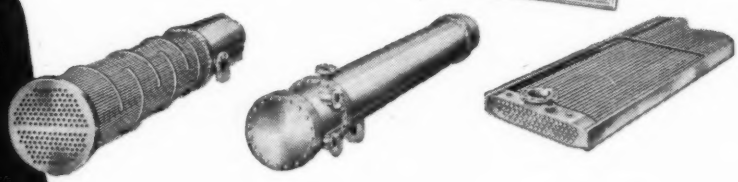


Booklet tells you why Aluminum Tubes stand up better against H_2S and products of sour crude



On your heat exchangers handling products of sour crude, H_2S, CO_2, or ammonia, you'll get two to 10 times the life from Alcoa Aluminum Heat Exchanger Tubes. Aluminum has high resistance to corrosive attack by these products, as well as by steam and most cooling waters.

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South Jennings plant for nearly three years before going to La Rosa as plant foreman in May, 1947. He has been with Stanolind since 1943. He attended the University of Minnesota, and has an engineering degree from University of Texas.

* * *

Irving A. Cole is manager of the technical division of Attapulgus Clay Co. He was formerly with the research and development department of Atlantic Refining Co. at Philadelphia and Port Arthur and joined Attapulgus in 1946 to handle technical aspects of the development of new products.

* * *

Thomas G. Gibian is on the staff of the research and deveolpment department of Atlantic Refining Co., Philadelphia. He recently completed work for a Ph. D. at Carnegie Institute of Technology.

Floyd F. Campbell, a pioneer with Phillips Petroleum Co. in the LPG field, and for several years manager of its direct retail activities, has resigned from the company, to enter the independent consulting field. He will specialize in retail sales, business management and promotional activities in the LPG business, maintaining headquarters in Bartlesville. A graduate of Purdue University in chemical engineering, Mr. Campbell came with Phillips in 1928, soon after its Philgas division had been organized, and has taken an active part in the growth of the LPG industry. He is national chairman of the Appliance Committee of the Liquefied Petroleum Gas Assn.

Mr. Campbell

* * *

Howard R. Peterson has been elected vice president of Indoil Chemical Co., chemical subsidiary of Standard Oil Co. (Indiana). He will continue as sales manager, which position he has held since the chemical subsidiary was set up three years ago. He is a graduate of the University of Nebraska and studied in the Sorbonne, Paris, after overseas service in World War I.

* * *

H. R. Alfson is gas engineer for General Petroleum Corp. at Worland, Wyo. He joined the company in 1929, served as operator in a gas absorption plant, laboratory technician and in 1945 was advanced to chemist at the Vernon, Cal., laboratories.

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

"Selling" Oil's Biggest Customer

A WORTHWHILE SERVICE has been done on behalf of the petroleum industry by R. J. S. Pigott, of Gulf Research & Development Co., in the discharge of his duties as president for 1948 of the Society of Automotive Engineers. During his year in office he made 52 talks before local sections of the SAE over the country and including the Hawaiian Islands, a record probably never equalled by any previous SAE president.

His talks, along the lines of his paper before the recent SAE annual meeting, were in part a long-term appraisal of petroleum and other energy sources in the U.S. They also included, however, a discussion of the more immediate problems connected with supplying motor fuels of the quality required for the cars to be made the next few years. Mr. Pigott's appearances as a representative of the petroleum industry were incidental to his official duties. However, he undoubtedly accomplished a great deal in acquainting the rank and file of automotive engineers over the country with what confronts refiners in making the higher octane fuels for the cars the manufacturers would like to turn out in the not distant future.

The petroleum industry cannot always be so fortunate in having as its representative on automotive engineering forums a man with the official capacity held by Mr. Pigott. However, it has been fortunate in the past in the assignment of its leading technologists to discuss before the SAE the motor fuel supply situation. W. M. Holaday, director of the Socony-Vacuum research laboratories, has served very ably in this capacity on several occasions in the past two or three years. Undoubtedly this practice will continue, for the SAE has always welcomed representatives from the petroleum industry on its meeting platforms. Also it is most important at this time, with some car manufacturers pressing to increase the compression ratios of their new models, that the automotive engineers comprehend what this entails for the oil companies.

The utilization of motor fuels today is of such magnitude that changes in their characteristics involve both technological and economic problems which should be understood as widely as possible in both industries.

Standardizing Symbols of Science

ONE OF THE TOUGHEST JOBS for the reader of technical reports and articles is to be confronted with unfamiliar symbols for scientific words and figures, or to find symbols with which he is familiar given new and different meanings. A prominent example is the Greek symbol "γ", which in atomic spectra may mean energy, frequency or wave number. Another example is the present use of six or seven symbols to designate "current density".

Hence the announcement of the completion of the work of standardizing symbols for physics should receive the encouragement and cooperation of all technologists. The report is presented in the "American Standard Letter Symbols for Physics, Z10.6-1948", by the Science and Engineering Symbol and Abbreviation Committee of the American Standards Assn. The head of the particular subcommittee which has done the work in the field of physics is Harold K. Hughes, Socony-Vacuum Laboratories, Brooklyn. Similar standards for electrical quantities and aeronautical symbols are under revision, while some eight sets of standards in other sciences have been prepared since the work was started in 1926.

The proposed standard physics symbols include all common terms in elementary physics and some in advanced physics and related fields. Those symbols have been omitted where usage has not developed to the point that standard meanings can be applied. The work has not been done arbitrarily but in cooperation with all interested agencies and much consideration has been given to the practice in the physics journals, textbooks and reference works.

The oil company research laboratories should take the lead in the adoption of the standard physics symbols, to expedite their general use.

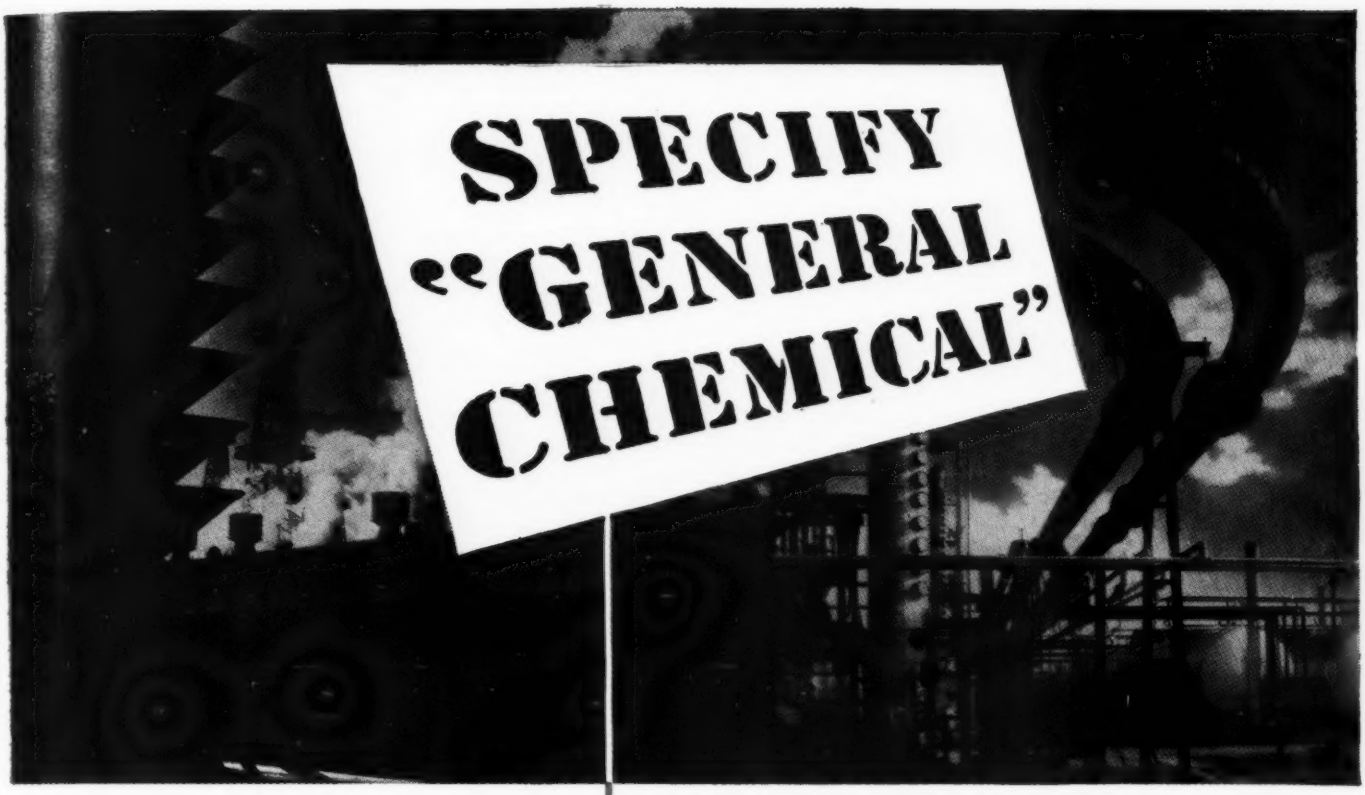
A New Threat of Regulation

A POSSIBLE NEW THREAT OF CONTROL of the natural gasoline industry lies in a suit filed in a state court at Baton Rouge by the Louisiana Public Service Commission. The Commission charges that the act of 1942 creating the Louisiana Liquefied Petroleum Gas Commission to regulate dealers in LPG products is unconstitutional. It asks that the liquefied petroleum gas industry of the state be declared a public utility. The state public service agency would then become the regulatory body.

The Liquefied Petroleum Gas Commission has extended its regulation only to LPG local dealers. The intentions of the Public Service Commission in the LPG field of course will not be known until the suit is decided. However, a statement in its petition in the case in court might logically be taken as the premise on which to attempt wider regulatory authority. The statement reads: "In its manner of production, its use and all other important particulars save and except the method of distribution to the ultimate consumer, liquefied petroleum gas is identical or similar to the so-called natural gas."

Such a statement is entirely erroneous, and ominous by inference. Apparently waved entirely aside is the fact that LPG products are the result of manufacturing processes, with the cost of the natural gas only one factor in determining the price of the product. Regulation of the LPG industry all the way in Louisiana would bring with it control of natural gasoline and cycle plant operations—something that to date has been denied the state and federal agencies, although eyed covetously by them in some instances.

If the issue in the Louisiana court is to substitute regulation of the natural gasoline industry for free competition among its members the public as well as the industry should know about it.



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